

1959

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*Conseil Permanent International pour
l'Exploration de la Mer*

CHARLOTTENLUND SLOT — DANEMARK

ANNALES BIOLOGIQUES

VOLUME NO. XVI

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Scheme for the Arrangement of the Material

I. Review of Investigations and Essential Results

Each Committee Chairman should here give a summary of the contributions received, i. e., a statement of the nature of the material as well as a short review of the position in the area—including the main results obtained—during the last calendar year (unless otherwise stated). This review should only in exceptional cases exceed 2 pages (about 10,000 units of type). Papers should reach the General Secretary not later than 1. May.

II. Tables and Conclusions

A. Environment

1. Strength and direction of currents: Especially data collected during spawning seasons.
- 2a. Temperature and salinity conditions: Tables and/or diagrams including anomalies.
- 2b. Seasonal temperature variations at selected stations: Data including anomalies.
3. Phosphate concentration, oxygen, etc.: Tables and diagrams to include anomalies.
4. Plankton conditions: Tables and/or diagrams, especially anomalies in distribution of indicator forms, phytoplankton patches, amount of plankton and fat content.
5. Abundance of benthonic food: Data.
6. The main meteorological features of the year: Data especially as to sunlight, rainfall, and direction and force of the wind.

B. The Fish

For each species in the following order: Gadoids (cod, haddock, saithe, others), flatfishes (plaice, dab, flounder, sole, witch, lemon sole, halibut, others), herring, sprat, mackerel, other pelagic fishes, eel, redfish, others.

1. Abundance and distribution of eggs and larvae.
2. Abundance of year-classes: Data derived from experimental hauls.
3. Size and age composition of commercial catches or landings.
4. Average length of age-groups: Data from experimental hauls and commercial catches, with standard deviations.
5. Rate of growth: Data from marking experiments and quantitative experimental hauls.
6. Rate of mortality: Data from marking experiments and quantitative experimental hauls.
7. Intensity of fishing: Data as to the fisheries considered in 3, 4, and 8.
8. Quantities landed:—
 - (a) Total catch (weight) of special fisheries.
 - (b) Percentage of large, medium, and small.
 - (c) Total number of the various species.
 - (d) Size and age composition of commercial catches or landings.

C. Shellfish

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CHARLOTTENLUND SLOT — DANEMARK

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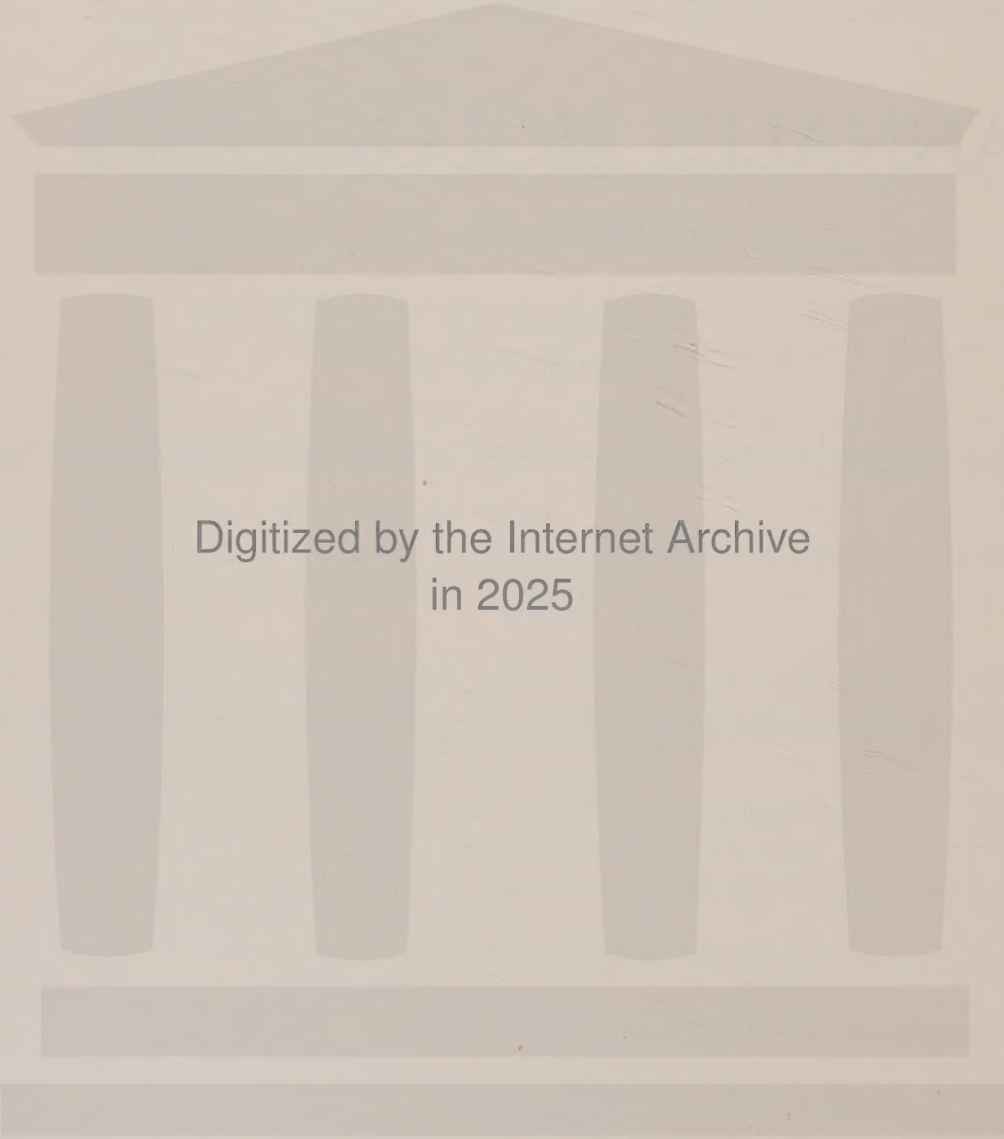
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PREFACE

The new arrangement of the *Annales Biologiques* which was introduced last year seems to be appreciated by the readers and will, therefore, be maintained. It is noted that this volume is considerably larger than any previous one, which is mainly due to more information on hydrography (Part I). In the last volume (for 1958) this section contained 35 pages as compared with 53 pages in the present volume.

We will first consider the *hydrographical conditions* and note the following features. The arctic component of the West Greenland Current was stronger than usual and the temperature remained generally below normal. In the northern North Atlantic the monthly anomalies of the surface temperature were still positive but a tendency towards lower values was clearly indicated. The Irminger Current and the Norwegian Current were stronger than usual and the East Icelandic Current was colder than normal. The temperatures were higher than normal throughout the whole Near Northern Seas area. In the North Sea the positive deviations amounted to 1° — $2\frac{1}{2}^{\circ}$ C. In the Baltic area the temperature was also above normal.

Information on *cod* comprises the West and East Greenland areas, Iceland, the Norwegian coast, the Bear Island and Spitsbergen area, and the Baltic. On the West Greenland banks the catches depended mainly on the same broods as in 1958, viz: the broods from 1947, 1950, 1953, and partly 1955, the brood from 1953 being particularly strong. Among the young fish the 1957 brood was extremely predominant as had been expected in 1958. Off East Greenland the 1945 and 1947 broods were still important but the 1950 brood was by far the best one, making out more than half of some of the catches. At Iceland the broods from 1950 and 1951 were generally predominating and in the cold water area the 1955 brood was also strong. The 1950 brood was also by far the strongest in the landings from the Norwegian coast whereas the yields from the Bear Island and Spitsbergen area were almost entirely based on 5 year-old fish. In the Baltic the proportion of young fish (the broods from 1957 and 1958) was extremely high. The brood from 1959 seems to be very strong.

There are records on *haddock* from Iceland, the Norwegian coast, from the Barents Sea, the Faroes, and the North Sea. At Iceland there was a dominance of 9 year-old fish (1950) but the broods from 1953 and 1954 were also rich. There were no outstanding dominants off the Norwegian coasts, the landings being mostly comprised by 4—8 year-old fish. In the Barents Sea the 1956 brood was rich and in the Faroe area the younger age-groups made up the greater parts of the landings as in previous years. In the North Sea the density of haddock had increased owing to the very rich year-class from 1958.

In respect of the *whiting* the broods of 1955, 1957, and 1958 were generally predominating in the North Sea, that of 1958 being the best one. There are no records on *saithe* in this volume.

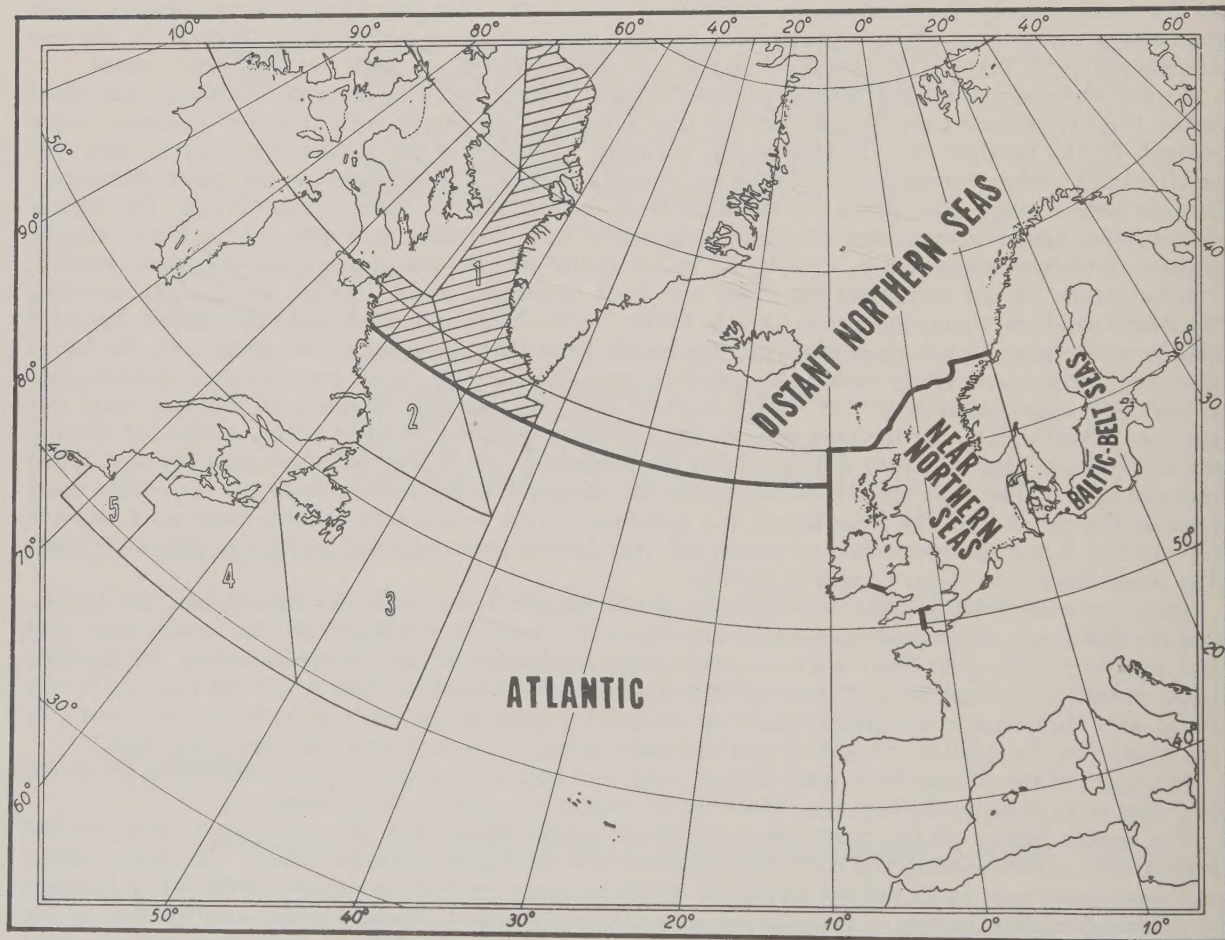
The *herring* fishery off the north coast of Iceland yielded better than for many years. Nine year-old herring were predominating and there were relatively few herrings of Norwegian origin. The winter fishery of Norway gave poor yields but the 9 year-old age-group made out half the catches. In the USSR landings of Atlanto-Scandian herring, 9 year-old fish was also predominant. There is a brief contribution on the international herring investigations in the Norwegian Sea. In the Scottish landings there was a general increase both in the North Sea and off the West Coast and fish with 2 winter-rings were greatly predominating. The same applied to the German landings from the northern North Sea. The German yields rose in 1959 by 8.3%. In the Dutch landings there was a general increase except in the north-eastern North Sea where a decline was noted. As in the landings of Scotland and Germany the 1956 year-class was very predominating. The Belgian landings consisted also mainly of young herring, and the Swedish and USSR North Sea landings show similar features. In the Polish landings from the Baltic the broods from 1953, 1954, and 1955 were predominant and the yield per day's fishing was about 14% higher than in 1958.

Attention is drawn to the important taggings of *sole* in the North Sea (pp. 92–97) and the reader is moreover referred to the sections on the Distant Northern Seas (pp. 90–91), Near Northern Seas (pp. 91–105), Baltic Belt Seas (pp. 106–117), Sardine (pp. 225–231), Scombriform Fish (pp. 232–245), Salmon and Trout (pp. 246–252), and Shellfish (pp. 253–261).

For further information concerning the fish stocks in 1959 reference is made to the *Statistical News Letters* Nos. 9 and 10. In No. 9 there are detailed records on North Sea herring in 1959, whereas No. 10 contains information on cod, haddock, whiting, plaice, sole, dab, and redfish, partly also for 1958.

My best thanks are extended to all chairmen and contributors, but I am specially indebted to Mrs. H. HARDER of the Central Office and her assistant, Mrs. M. FRIES, for their unremitting work in the preparation of this volume.

ÁRNI FRÍÐRIKSSON



Map showing the areas covered by the ICES, together with those covered by ICNAF. The hatched area is Panel 1.

CHAIRMEN'S SUMMARIES OF AREA REPORTS

Distant Northern Seas

Contributions to this report have been received from:—

Denmark:

P. M. HANSEN
F. HERMANN
J. SMED

England:

J. CORLETT

Germany:

G. KREFFT

Iceland:

H. EINARSSON
I. HALLGRÍMSSON
U. STEFÁNSSON

Norway:

E. BRATBERG
P. MYRLAND

Scotland:

J. H. FRASER
G. T. D. HENDERSON
T. LOVEGROVE
J. B. TAIT

Soviet Union:

A. ALEKSEJEV
I. A. ERMACHENKO
M. V. FEDOSOV
L. N. GRUZOV
B. ISTOSHIN
W. PACHORUKOV
E. A. PAVSTIKS
L. PONOMARENKO

The hydrographical contributions cover most part of the Distant Northern Seas area and present a clear picture of the general hydrographical conditions.

Early in 1959 the amount of drift ice in the Cape Farewell region was greater than usual. This was in accordance with a stronger influence of the arctic component of the West Greenland Current. Throughout the summer the temperature prevailed somewhat below normal in East Greenland waters, south of the Angmagssalik region. All over this area the temperatures were found to be suitable for the occurrence of commercial fish.

The studies of the monthly anomalies of the surface temperature in the northern North Atlantic have been continued. Although the yearly averages are still positive, a tendency towards lower temperatures is clearly indicated.

The ice border off Jan Mayen was situated abnormally far eastwards in early summer, but west of Iceland it was normal.

In Icelandic waters and in the southern Norwegian Sea extensive observations were made of

dissolved oxygen and phosphates. Detailed investigations of both dissolved and suspended silicates in northern waters are described.

The Atlantic waters between the Faroe Ridge and the Reykjanes Ridge was of similar thickness as in 1958. The Irminger Current and the Norwegian Current both were warmer than usually, especially the Irminger Current. However, the East Icelandic Current was considerably colder than usual. Thus the water circulation in northern waters in 1959 appears to have been stronger than normally observed.

The contributions on plankton cover a wide part of the area.

In 1959 the standing crop of plankton in the Bear Island area was about the average of the years 1953—1958 as measured by the dry-weight plankton.

Plankton was poor in January and February, as usual. Maximum development of phytoplankton was observed in May. A characteristic feature was the extended distribution of *Calanus hyperboreus* in the western and northern part of the Norwegian Sea in May/June. These good feeding conditions, however, were poorly used by the herring.

The total number of plankton organisms in 1959 in the Norwegian Sea was higher than the average for the last ten years, and this was mainly caused by the great number of *Calanus hyperboreus* and the rich development of phytoplankton.

Interesting results were also presented from the continuous plankton recorders, especially on the distribution of the young *Sebastes marinus* along a route from Reykjavik to New York. Comparison with earlier years suggests that *Sebastes* in the area south of Iceland were more abundant in 1959 than in 1958, but less numerous than in 1957.

JÓN JÓNSSON

Near Northern Seas

Contributions to this report have been received from:—

Denmark:	J. F. DE VEEN
K. P. ANDERSEN	J. J. ZIJLSTRA
AA. J. C. JENSEN	
J. SMED	Poland:
H. THOMSEN	J. FILARSKI
	J. ROMANSKI
Germany:	Scotland:
E. GOEDECKE	B. I. BARNES
A. KOTTHAUS	R. E. CRAIG
P. F. MEYER-WAARDEN	J. H. FRASER
E. ROGALLA	R. S. GLOVER
E. ZIEGELMEIER	J. M. LAMONT
	T. LOVEGROVE
Netherlands:	B. B. RAE
L. OTTO	Sweden:
K. H. POSTUMA	A. SVANSSON
M. ROESSINGH	

I. Hydrography

Temperature and salinity charts are presented for three extensive Scottish surveys in the northern North Sea. Temperature did not deviate much from normal, but declined more slowly than usual in August, so that autumn values were about 1°C above normal in the surface layer. Salinities were unusually high in the northern section, and water circulation was extremely slow in the year 1959.

The German fishery research vessel "Anton Dohrn" provided the data for charting the layering of water masses in the North Sea in the period June/July 1959. The pattern of bottom salinities reveals the presence of five bodies of water of different origin, whereas the temperature pattern in the deeper layers reveals considerable horizontal differences, predominantly due to local conservation of winter water and to local differences in the force of the tidal currents.

Hydrographical data collected by the research vessel "Anton Dohrn" in the southern North Sea and the English Channel in January 1959 are presented. Though horizontal differences were striking at that time, the water appeared to be generally very uniform vertically.

The Netherlands research vessel "Willem Beukelsz" collected hydrographical data in the central and southern North Sea between 13. July and 1. August. Surface temperatures were 1–2½°C higher than normal. Surface salinities appeared to be high north of the Dogger Bank, but low in the German Bight area. The latter phenomenon is ascribed to poor mixing conditions. Bottom tem-

peratures were rather high on the whole, bottom salinities rather low.

During the October herring cruise of the "Anton Dohrn" hydrographical data were collected in the Dogger Bank region. The salinity pattern reveals the presence of three water masses of different origin: Atlantic water, North Sea water, and coastal water. A body of cold bottom water was found under a discontinuity layer, but the water masses over the Dogger Bank itself were not stratified.

German commercial vessels continued temperature and salinity observations on the Hamburg-Hull route. The warm and dry weather in 1959 led to abnormally high surface temperatures in the whole southern North Sea. The reduced run-off of the rivers led to high salinities in the coastal waters.

Again, temperature and salinity observations were made from five German lightships. Here too surface temperatures were comparatively high almost throughout the year 1959, whereas surface salinities were high in the March/May period, and from October to December.

Again, thermograph data are presented for the North Minch. Unusually high temperatures were recorded there from September to December 1959.

In the Kattegat, surface temperatures were above normal throughout the year 1959, bottom temperatures were unusually high in winter. Salinities too were above normal in 1959.

In Swedish waters exceptionally high salinities were found in the deeper water layers in December. Surface temperatures were above normal there throughout the year.

II. Plankton and Benthos

Again, plankton investigations from Aberdeen gave an insight in the fluctuations in abundance in the course of the year of a variety of plankton organisms. Of the phytoplankton it is noteworthy that *Skeletonema costatum* dominated in the Scottish waters in spring, together with *Thalassiothrix nitzschoides*. By the summer the coastal phytoplankton had become much reduced. In the coastal part of the North Sea *Ceratium microceros* and *Ceratium tripos* dominated the phytoplankton at that time. The Aberdeen zooplankton studies gave a good insight in the type of water encountered, and in the feeding conditions for pelagic fish. There appeared to be a good mixed community

early in the year 1959, leading to a good production of copepods, and good feeding for herring. A strong inflow of oceanic forms into the Faroe Channel continued until October.

The Continuous Plankton Recorder was again used to study the plankton around the British Isles at monthly intervals. Again, spring flowering of phytoplankton occurred earlier in the North Sea than in the Atlantic. In the North Sea the number of diatoms in spring was higher than in 1958, but fell to an unusually low level in summer and autumn. Species of smaller copepods were abundant in the north in 1959, but *Calanus*, after a normal start in the spring, became scarce for the rest of the year. Between June and September the average number of *Calanus* was lower than the comparable figure in any year since 1947. The year 1959 differed greatly from 1958. Many forms recorded as abundant in 1958 were scarce in 1959, and vice versa. There appeared to be a return to the plankton conditions prior to 1952. The 1959 zooplankton situation closely resembled that of 1949. The invasion of Atlantic coastal water in the North Sea was clearly indicated by the zooplankton organisms.

Investigations of the bottom fauna was continued in the German Bight. High biomass figures were found in autumn 1959. The number of lamellibranchs showed a further increase. The species *Angulus fabula* was especially numerous. The shellfish predator *Lunatia nitida* increased in numbers, together with the lamellibranchs. Information is presented on the abundance of various species of polychaetes, crustaceans, and echinoderms in the year 1959.

III. The Fish

The sampling of plaice eggs from Dutch light-vessels is described. Egg numbers observed per tide are shown in the graph, with indications on the developmental stages of the eggs. It is assumed that these data can give a rough impression of spawning activities in the Southern Bight plaice population, though aberrant wind directions might cause many eggs to drift away from the lightvessel area. There are indications that this work may lead to interesting results.

Releasing data of the German sole tagging experiments are presented, and the position of the returned tagged soles is given, together with the number of days between tagging and recapture, and length differences. A westward migration has been

ascertained in the second half of the year, and the growth pattern tallies with earlier conceptions.

Preliminary results of sole tagging experiments carried out by the Netherlands are presented in figures depicting the localities of tagging and the position of recaptures, together with information on the Netherlands fishing intensity. The data presented per quarter indicate a low number of returns in the winter season, not to be ascribed to lower fishing intensity, and considerably greater numbers of returns in the following spring and summer. Many returns coincide both in place and time of the year with the tagging operations the year before. These data hint at an annual cycle in the life of the sole.

The continuation of Danish investigations on flatfish in the Skagerak-Kattegat area is described. 0-group plaice was locally found in great numbers, especially in coastal waters in the southern Kattegat, where its frequency was as high as nine times the normal. The II-group plaice was unusually numerous in the northern Kattegat, being immigrated to this area since November 1957. Emigration and immigration are in these waters factors of great influence on the frequency of occurrence of plaice of various year-classes. Fishing has considerable influence as soon as the 26 cm size limit is attained.

Whiting investigations carried out by the Netherlands provided information on the relation between latitude and the average number of vertebrae. This number shows a clear-cut rise from south to north, but remains rather constant north of the Dogger Bank. Eight out of 200 tagged whittings returned thus far indicate a migration in southerly direction. Some results of Netherlands market measurements for whiting in the years 1958 and 1959 are presented, together with information on the catch per unit of effort.

Analysis of a great number of experimental trawl hauls gives a good insight in the by-catch of the Polish mixed fishery. Herring constituted 87.7% by weight in the 1958/1959 catches.

The 1959 yield of the German sand-eel fishery was lower than in the preceding years, and the average catch per trip was lower too. Analysis of samples gives an insight in the nature and the quantity of the by-catch: a very low percentage of undersized protected species only.

A list of rare fishes recorded in Scotland is presented.

P. KORRINGA

Baltic-Belt Seas

Contributions to this report have been received from:—

Denmark:	W. MANKOWSKI
AA. J. C. JENSEN	Z. REIMANN
H. THOMSEN	K. SIUDZINSKI
	K. WIKTOR
Germany:	L. ZMUDZINSKI
E. GOEDECKE	
R. KÄNDLER	
A. KOTTHAUS	
	Sweden:
Netherlands:	A. SVANSSON
J. DE VEEN	
	U. S. S. R:
Poland:	I. I. NIKOLAEV
W. CIEGLEWICZ	N. K. KRIEVS
A. GLOWINSKA	A. T. SHURIN

I. Hydrography

According to Danish, German, Polish, Swedish, and Soviet observations in 1959, high temperatures of the surface waters in the whole area were observed. Polish and Soviet observations indicate that during the autumn of 1958 and winter of 1959 a slight renewal of the bottom layers took place in the central Baltic due to the inflow of North Sea waters. Also SVANSSON observed some intrusions of Kattegat water into Bornholm Deep, but in the Landsort and Gothland Deeps he found a decrease in salinity and oxygen content.

II. Plankton and Benthos

According to NIKOLAEV and KRIEVS the absence of the salt-water species *Sagitta elegans baltica* and *Oithona similis* in the area east of Bornholm Deep may be taken as an index of lower salinity in the deeps. These authors observed during 1959 in the Baltic proper and the Gulf of Riga mostly higher values of the biomass of zooplankton (Copepoda) than those of the long-term average (1949/59). Also MANKOWSKI states the absence of *Sagitta* in Gdansk Deep as a result of a decrease in the salinity in this region. According to SHURIN's observations in 1958/59 the decrease in the amount of bottom fauna in the eastern Baltic, in particular the Gothland Deep, was caused by a deficiency in oxygen and the appearance of hydrogen sulphide in the latter deep at 80—90 m to 240 m depth. The feeding grounds for fish in this area were in 1959 confined to about 78 m depth as compared with

120 m in 1949. SIUDZINSKI and ZMUDZINSKI announce the discovery of *Sphaerodorum balticum* Reimers on the ridge between the Bornholm Deep and the Slupsk Furrow.

III. The Fish

According to KÄNDLER the number of cod eggs per m² near the "Fehmarnbelt" lightvessel was in 1959 still low, though somewhat higher than in the previous year. The number of plaice eggs was also very low, whereas that of flounder was higher and that of dab similar to the 1958 observations. The absence of sprat eggs indicate the poverty of the stock of adult fish. According to MANKOWSKI's observations in the southern Baltic the spawning of the cod was rather poor, estimated on the basis of number of eggs per m², while that of the sprat was fairly good. JENSEN found larger quantities of young plaice and flounder (groups 0 and I) in the Belts and western Baltic than normally, and the 0-group sole also occurred in relatively large numbers in the Køge Bay. The stock of plaice in the open sea is sustained by the strong 1957 and 1958 year-classes. At Bornholm the density of the stock of plaice outside the 35 m line had doubled since 1958.

On the basis of experimental fishing with the standard trawl KÄNDLER also states that the 1957 year-class of plaice was represented with higher numbers than in any of the most recent years. Of dab, very rich 1957 and 1958 year-classes were observed. The yields of the Polish fishery for flat-fish were higher than in previous years. Relatively high proportions of III-group flounder and plaice were observed in the catches taken in Gdansk Bay.

Due to the high water temperatures in spring, the 1959 year-class of cod was plentiful in the Petersen young-fish trawl, according to KÄNDLER's investigations. On the other hand, the 0- and I-groups were less frequent in October than in 1958. In his opinion the stock of marketable cod is poor.

JENSEN's forecast of good catches of silver-eel in the Belts and Baltic, estimated on the basis of the summer temperature of the surface water, was successful. The Danish catches were about twice the normal.

W. CIEGLEWICZ

PART I.
HYDROGRAPHY

A. Distant Northern Seas

Norwegian Investigations in Greenland Waters in 1959

(Figures 1-4)

West Greenland

As in previous years, hydrographic observations were carried out in the waters off West Greenland. The Norwegian R/V "Johan Hjort" visited West Greenland in April. In July/August both West Greenland and East Greenland waters were visited by "G. O. Sars".

On the first cruise, six hydrographic sections were occupied and, in addition, temperature registrations were made by means of bathythermograph readings at all fishing stations.

The hydrographic sections were situated between the following positions:—

	N	W	N	W
Noname Bank	61°46', 49°40'	—	61°29', 50°52'	
Frederikshåb Bank ...	62°15', 50°20'	—	61°53', 52°30'	
Dana Bank	62°50', 50°48'	—	62°17', 54°00'	
Fiskenes Bank	63°27', 51°40'	—	63°16', 52°44'	
Fylla Bank	64°02', 52°20'	—	63°41', 55°15'	
Banana Bank	64°30', 52°25'	—	64°19', 55°49'	

Figure 1 shows the isotherms in the section across the Frederikshåb Bank.

In April the arctic component of the West Greenland Current was relatively well developed. Cold arctic water with temperatures below 2°C covered the top of the banks and the upper slopes. On the southern banks the cold water reached down to great depths, on Noname Bank to about 200 m. Further north, on the Banana Bank, the cold water penetrated only to about 90 m depth. Below this cold layer warmer water of Atlantic origin was encountered.

On the second cruise in July/August, seven hydrographic sections were made between 27. July and 11. August. The sections were between the following positions:—

	N	W	N	W
Noname Bank	61°41', 49°40'	—	61°18', 51°51'	
Frederikshåb Bank ...	62°13', 50°19'	—	61°52', 52°30'	
Dana Bank	62°52', 50°47'	—	62°28', 52°57'	
Fylla Bank	64°00', 52°36'	—	63°49', 54°05'	
Central part of				
Lille Hellefiske Bank	65°03', 53°04'	—	64°56', 55°18'	
Northern part of				
Lille Hellefiske Bank	66°03', 54°09'	—	65°58', 55°56'	
Across Holsteinsborg				
Deep	66°26', 54°26'	—	66°36', 54°30'	

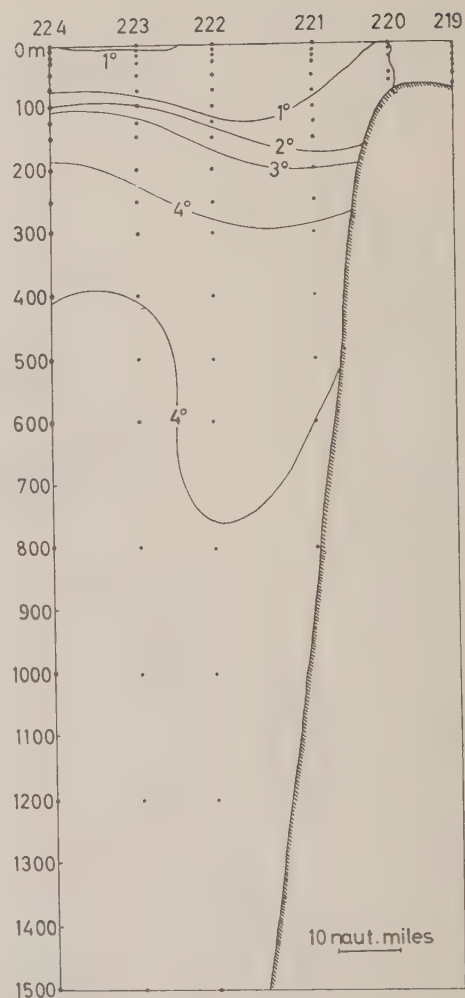


Figure 1. R/V "Johan Hjort", West Greenland, April 1959. Temperature section from Frederikshåb Bank and westwards.

The isotherms in the sections across Frederikshåb Bank and across the central part of Lille Hellefiske Bank are shown in Figures 2 and 3. The hydrographical situation differed in some respects from that prevailing in April. The surface water was still characterized by both the arctic and Atlantic components of the West Greenland Current. The Atlantic component is more developed. It was, however, observed that the cold water still in the late summer covered the top of the banks and the

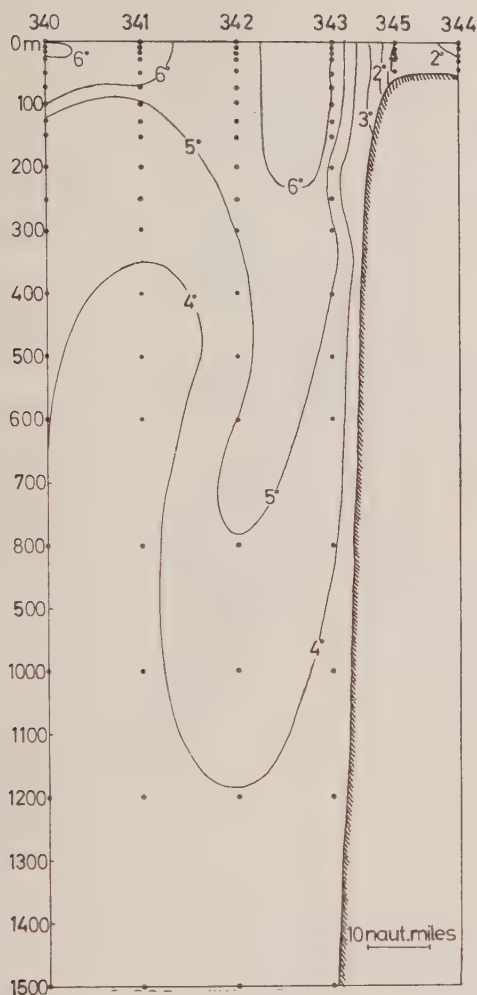


Figure 2. R/V "G. O. Sars", West Greenland, July 1959. Temperature section from Frederikshåb Bank and westwards.

inner slopes, while the thick layer of Atlantic water covered the outer slopes of the banks.

On the northern banks the situation had changed even more from April to August. There the surface layer was not so much influenced by the arctic water. Mixed water with temperatures above 2°C covered the top of the banks while on the western slopes a core of cold water with temperatures below 2°C was observed. The origin of this water is presumably the Labrador Current. Below this layer of cold water, Atlantic water covers again the slopes of the banks.

Figure 4. R/V "G. O. Sars", East Greenland, August 1959. Temperature section from Prins Christian Sund and eastwards.

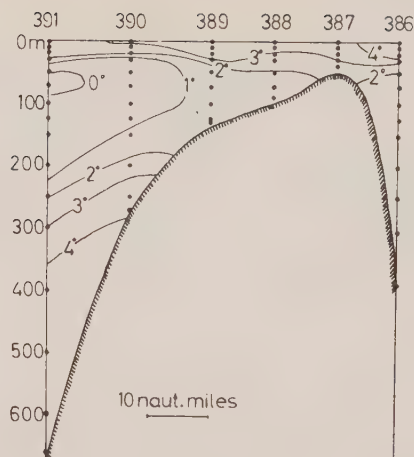
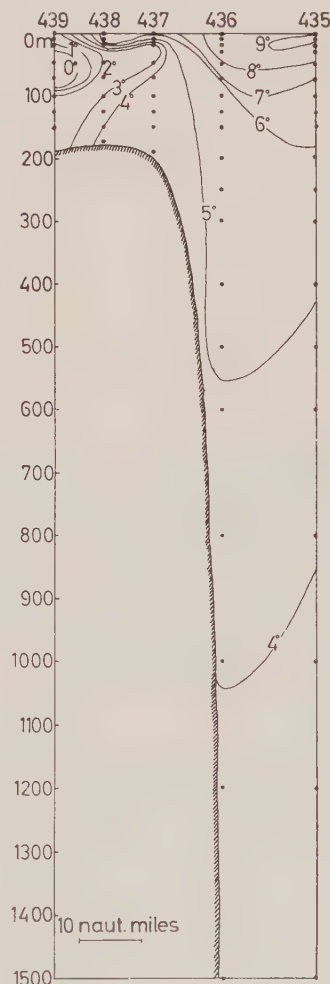


Figure 3. R/V "G. O. Sars", West Greenland, August 1959. Temperature section from the central part of Lille Hellefiske Bank and westwards.



East Greenland

The following hydrographic sections were occupied off East Greenland:—

	N	W	N	W
Angmagssalik	65°14'	36°08'	64°44'	34°25'
Across the southern part of Denmark Strait ..	66°00'	30°56'	65°08'	26°10'
Prins Christian Sund ..	60°04'	42°35'	60°03'	41°24'
Cape Tordenskjold	61°24'	42°06'	61°24'	40°43'

The first two sections were occupied on 6. and 14. July respectively, while the second two were worked on 16. and 19. August.

Figure 4 shows the isotherms in the section Prins Christian Sund — eastwards.

In August the water masses in the area investigated were characterized by two parallel west- and south-west-going currents (the East Greenland Polar Current and a branch of the Irminger Current). The eastern current (of Atlantic origin) was well developed and, at this time of the year, the cold arctic water did not penetrate to any great depth. Only in few localities was the 2°C isotherm encountered below 125—150 m. In other words, all over the investigated area the temperatures were suitable for occurrence of fish. Only the highest peaks of some banks and the upper part of the slope of the coastal shelf were covered by water with temperatures unfavourable for commercial species of fish.

ERLING BRATBERG

Hydrographic Conditions in the Davis Strait in 1959

(Figures 5–10)

In July 1959, the stations shown in Figure 5 were worked by R/V "Dana". The figure further shows the temperature distribution at 50 metres. It is seen that over the southern banks, from Fylla Bank and southwards cold conditions are prevailing, which shows that the influence of the arctic component of the West Greenland Current here is very strong. This is in good accordance with the fact that greater amounts of »Storis« than usual were carried round Cape Farewell earlier in the year.

Over the shallow part of Lille Hellefiske Bank the temperatures were only a trifle below normal, but west of the bank the cold Baffin Island Current was extending much farther to the east than usual, so very cold conditions prevailed here between 50 and 150 metres.

As usual it was found that a part of the West Greenland Current turns westward between 64°N and 65°N.



Figure 5. Location of sections and distribution of temperature at 50 metres.

Over the shallow part of Store Hellefiske Bank the temperatures were about normal. The influence of the arctic component of the West Greenland Current is relatively moderate here and the conditions depend more on the local meteorological conditions than on the origin of the currents.

The conditions are further illustrated by sections I to IV. In the Atlantic component of the West Greenland Current, here found as an undercurrent, both temperature and salinity were lower than in 1958 in the two southernmost sections, but not in section III off Holsteinsborg, where relatively warm conditions prevailed in the deeper layers.

A fixed station at the entrance to Godthåb Fjord (64°07'N—51°53'W) was worked frequently

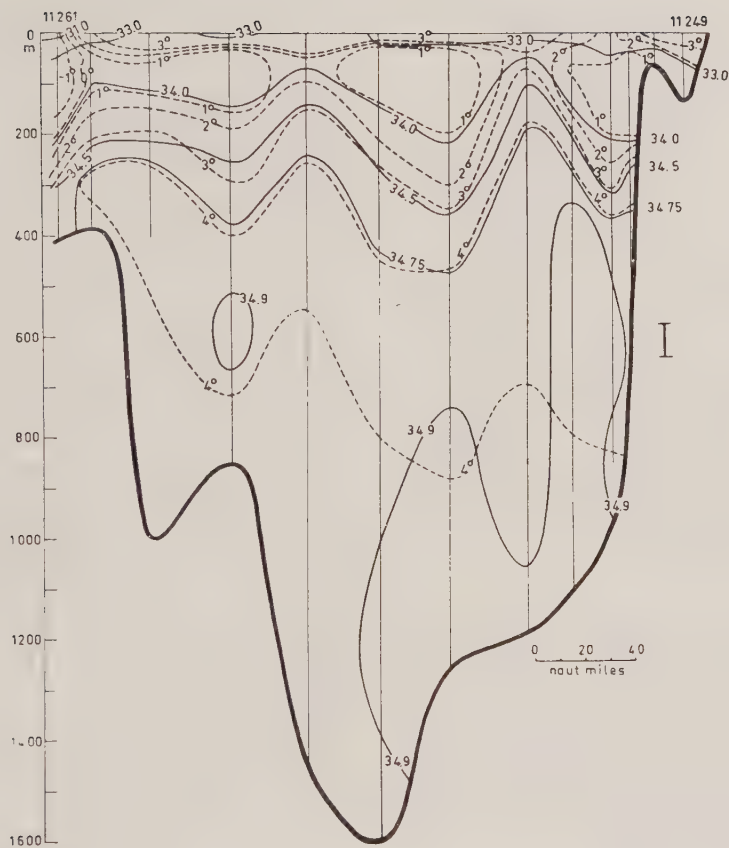


Figure 6. Section I across Fylla Bank, 18.—20. July, 1959.

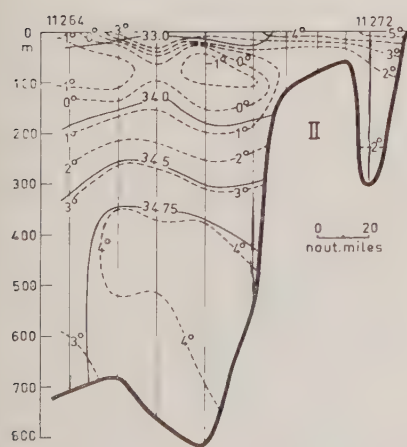


Figure 7. Section II across Lille Hellefiske Bank, 21.—22. July, 1959.

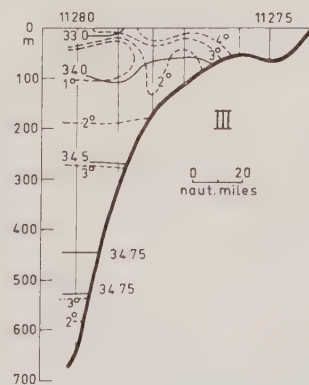


Figure 8. Section III across Store Hellefiske Bank, 23.—24. July, 1959.

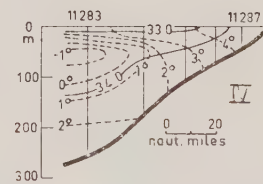


Figure 9. Section IV off Egedesminde, 25. July, 1959.

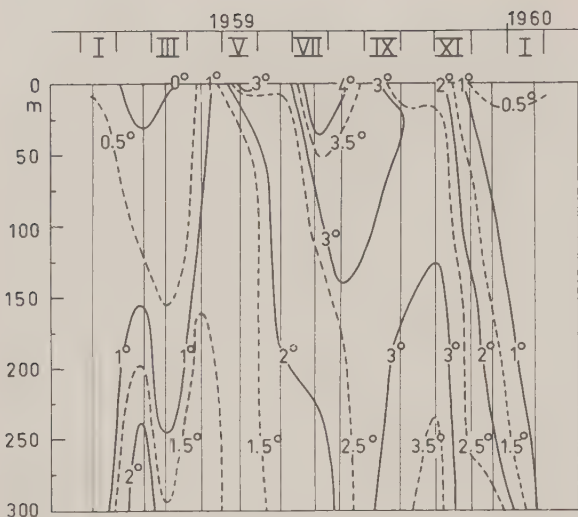


Figure 10. Variation of temperature at the entrance to Godthåb Fjord.

throughout the year with the M/C "Adolf Jensen" and M/C "Tornaq". Figure 10 shows the variation of temperature there. The winter cooling in the first months of 1959 was not very strong and was in the deeper layers counteracted by an inflow of warm water in February. A new and stronger inflow of warm bottom water took place in October/November, when the bottom temperature reached maximum, as in the previous years.

FREDE HERMANN

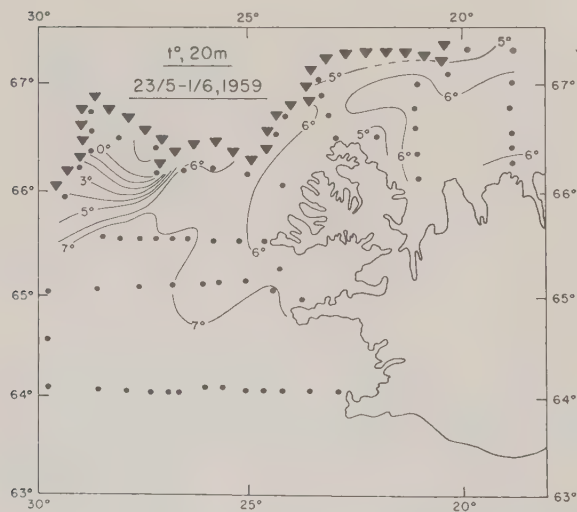


Figure 11. Temperature distribution, 20 m, 23. May to 1. June 1959.

Hydrographic Conditions in Icelandic Waters in May—June 1959

(Figures 11–18)

Hydrobiological surveys were carried out in the waters west and north of Iceland during two cruises from 23. May—24. June. Figures 11–18 show the location of the stations worked and the distribution of temperature and salinity at 20 and 100 m. The ice border is indicated in Figures 11 and 15.

During the first cruise (23. May to 1. June) the southern part of the Iceland-Greenland Ridge was ice-free within some 180 miles WNW off Látrabjarg. Farther north, however, the drift-ice limit was closer to the coast of Iceland than normally. During the second cruise (6.—24. June) the ice conditions were about normal off the north-west and north coasts.

Off the west coast the temperature was about normal or slightly above in the surface layers during the first cruise and about normal during the second cruise¹). The salinity distribution (Figs. 12 and 16) shows very distinctly the tongue of Atlantic water extending north-east across the Iceland-Greenland Ridge towards the north Icelandic coastal area. As usual, the front between Atlantic and Polar water was rather sharply defined.

The temperature and salinity distribution as observed during both cruises indicate an unusually

¹) Stefánsson, U., 1960. "Temperature at 20 meters in Icelandic waters in May 1956—1959." *Rit Fiskideildar*, 2, (8).

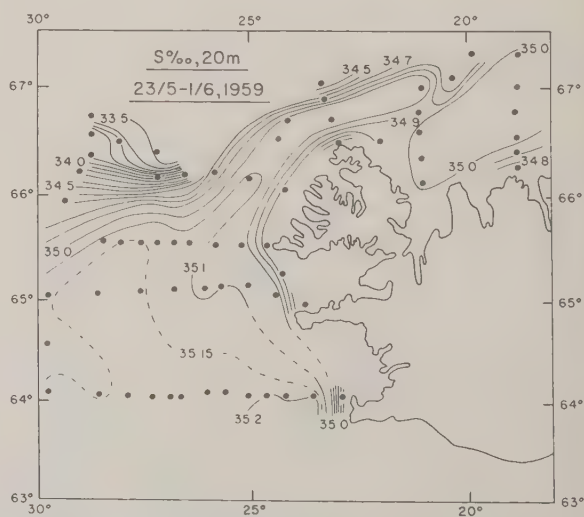


Figure 12. Salinity distribution, 20 m, 23. May to 1. June 1959.

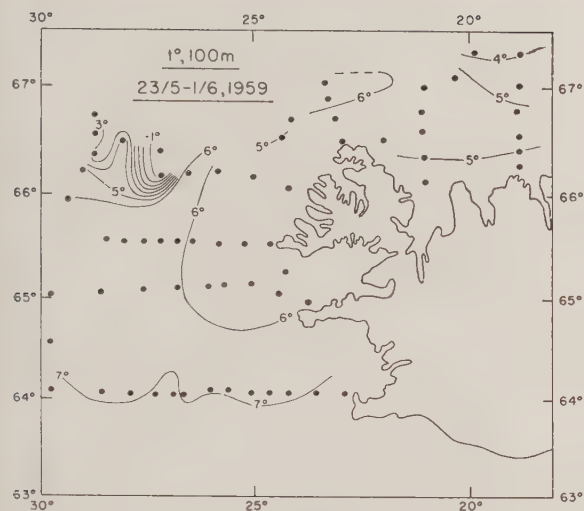


Figure 13. Temperature distribution, 100 m, 23. May to 1. June 1959.

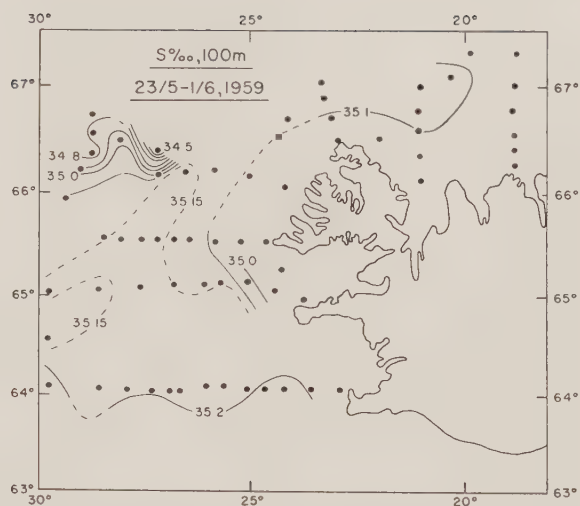


Figure 14. Salinity distribution, 100 m, 23. May to 1. June 1959.

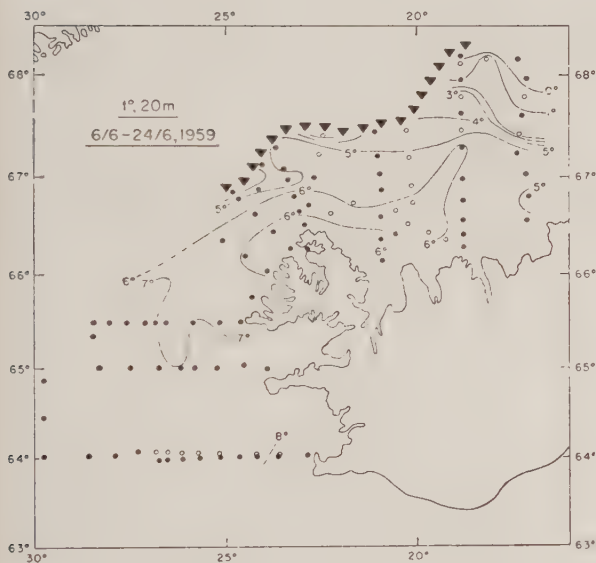


Figure 15. Temperature distribution, 20 m, 6.—24. June 1959.

The black circles indicate hydrographic stations and the open circles BT stations.

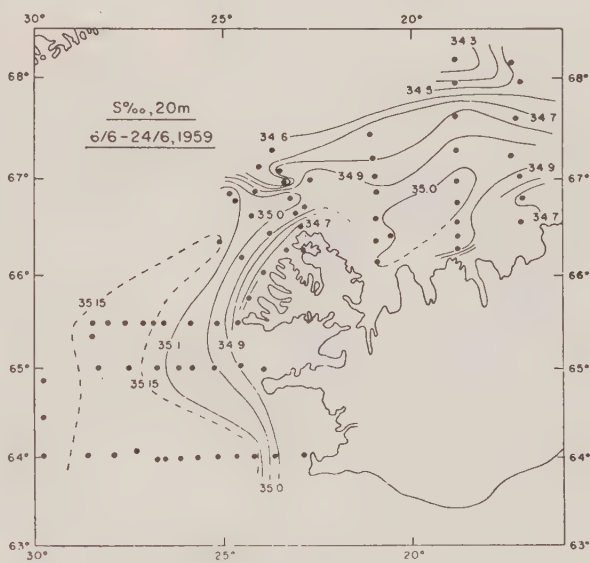


Figure 16. Salinity distribution, 20 m, 6.—24. June 1959.

strong influx of Atlantic water to the north Icelandic shelf region. The temperature at 20 m was about 1—2°C above normal on the north Icelandic grounds during the first cruise and about 0.5—1°C above normal during the second cruise¹).

At 100 m the temperature and the salinity were normal off the west coast, but higher than normal off the north coast, the temperature by about 1°C the salinity by 0.05—0.10 ‰. Comparison with previous years show that off the north coast the temperature at this level was 2—3° higher than in June 1958, but similar to what it was in June 1957. The salinity was higher than has been observed in the region north of Iceland since 1954.

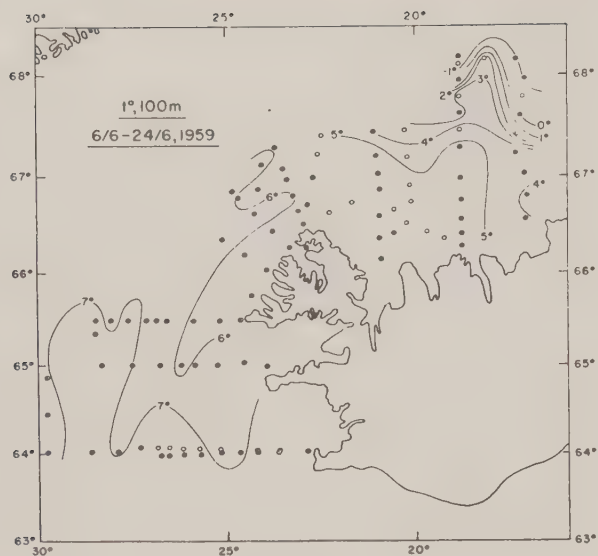


Figure 17. Temperature distribution, 100 m, 6.—24. June 1959. Symbols as in Fig. 15.

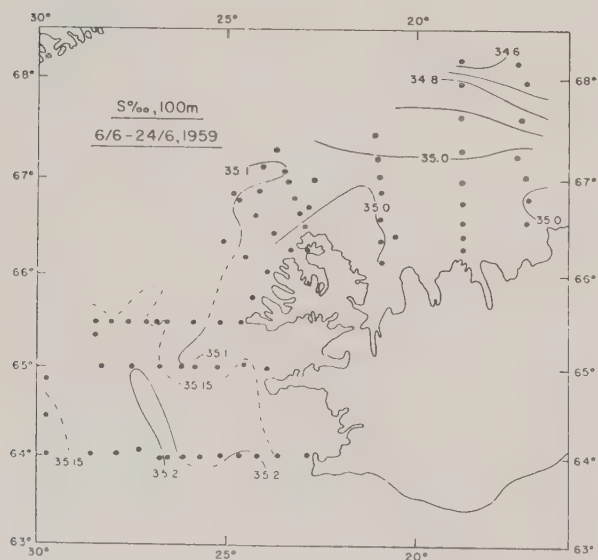


Figure 18. Salinity distribution, 100 m, 6.—24. June 1959.

Judging from the low temperatures recorded in the north-eastern part of the region during the second cruise, the water of the East Icelandic Current was considerably colder than usual.

UNNSTEINN STEFÁNSSON

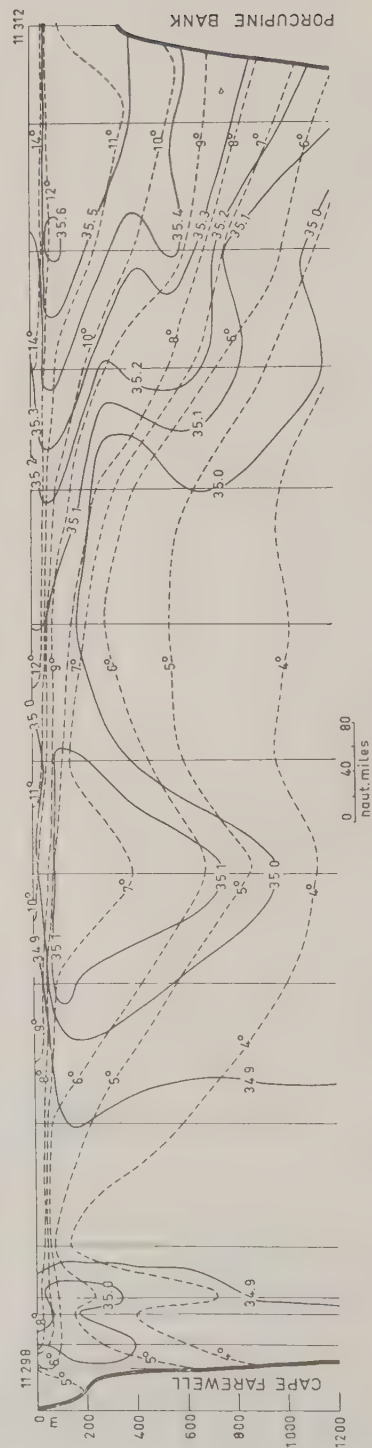


Figure 21. Section Cape Farewell to Ireland, 13. to 19. August 1959.



Figure 19. Location of sections.

Sections from the Faroes to East Greenland and Cape Farewell to Ireland

(Figures 19-21)

Two transatlantic sections, the positions of which are seen in Figure 19 were worked by R/V "Dana" in 1959. The Faroe-Greenland section is shown in Figure 20.

The warm Atlantic water, encountered between the Faroes and Reykjanes Ridge was of approximately the same thickness as in 1958. Off the slope of the Faroes cold bottom water was found, which must be deep water from the Norwegian Sea flowing out through the Faroe Bank Channel. The high salinities show that the water is somewhat mixed with Atlantic water.

West of Reykjanes Ridge the north-going Irminger Current was observed. This year it seems to be unusually well developed. Also the south-going branch of the Irminger Current observed off the Greenlandic slope was well developed. As in previous years, very cold bottom water was found in the deepest part of the Irminger Current. This water must originate mainly from Norwegian Sea water overflowing the Iceland-Greenland Ridge.

A belt of heavy polar ice made observations over the Greenlandic shelf impossible.

FREDE HERMANN

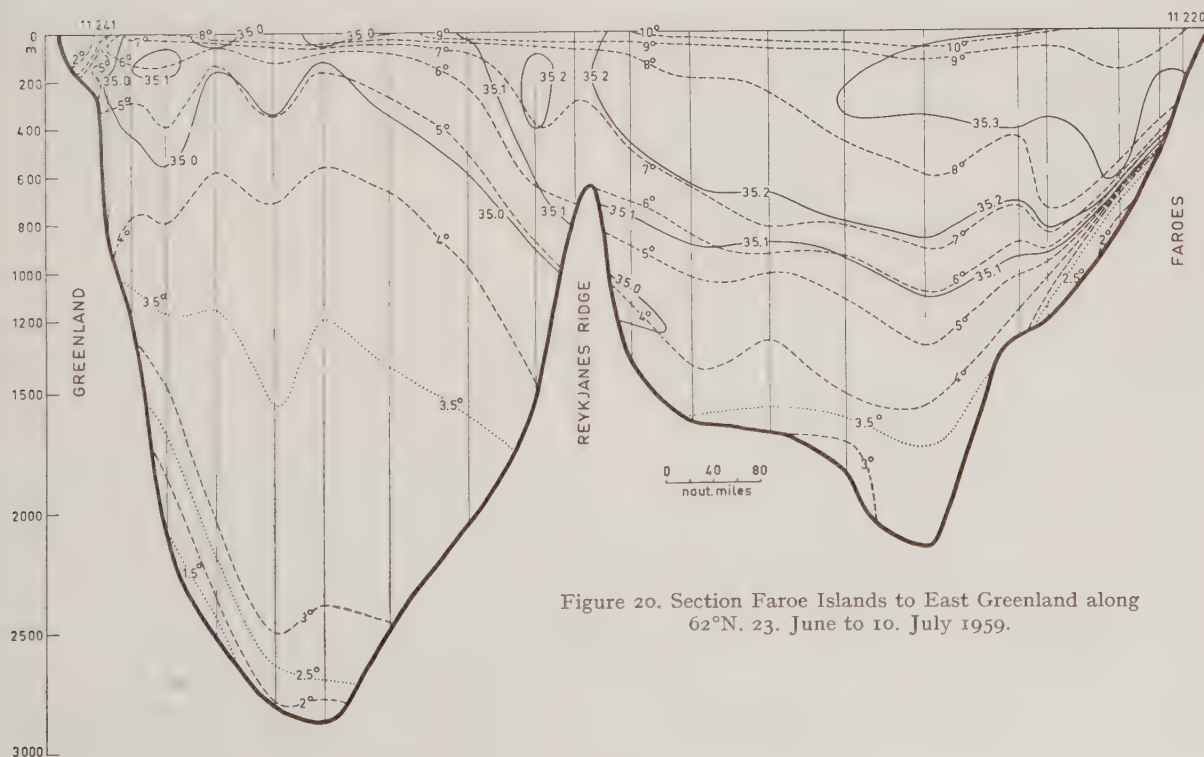


Figure 20. Section Faroe Islands to East Greenland along 62°N. 23. June to 10. July 1959.

Table 1 shows that positive anomalies still predominate during 1959. Thus for all areas except the two southernmost ones (E and N) the yearly averages of monthly anomalies are positive, as seen from the last column of Table 1. The distribution of these yearly anomalies over the region is shown in Figure 22. Evidently, the anomalies are highest in the north-eastern part of the region.

The average of the yearly anomalies given in the last column of Table 1 is 0.6°C , which is 0.2°C lower than in 1958. Figure 23 shows the geographical distribution of the variation of temperature from 1958 to 1959. It appears that there is a tendency towards lower temperatures over the whole region, excepting the area B, where there was a considerable lowering of temperatures from 1957 to 1958, and the easternmost areas J and K. That there is a rise of temperature in the areas J and K tallies well with the fact that a temperature rise has also been made out for the neighbouring North Sea area (see page 53).

Table 2. Grand monthly means of the surface temperature ($^{\circ}\text{C}$) at Myggenæs, Faroes (My in Figure 21) during the period 1914–1950 and deviations for 1959 from these means

	Jan.	Feb.	March	April	May	June	
Means							
1914–50	6.3	6.0	5.9	6.3	7.1	8.2	
Deviations							
1959	–0.5	0.4	0.8	0.7	0.8	0.8	
	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Means							
1914–50	9.3	9.8	9.7	9.1	7.9	7.0	7.7
Deviations							
1959	0.5	0.7	1.0	1.3	1.1	0.9	0.7

Table 2 gives the grand monthly means of the surface temperature at Myggenæs, Faroes (Station My in Figure 21) for the period 1914–1950, together with the deviations of the 1959 values from these means. The average of the monthly deviations is 0.7°C which means a rise from 1958 of 0.8°C .

I am indebted to Messrs. I. SESTOFT and H. THOMSEN of the Danish Meteorological Institute for placing the data at my disposal before publication.

JENS SMED

Silica Content of Northern Waters

(Tables 3–5)

It has been known from the results of previous investigations (ATKINS, 1926; COOPER, 1933) that, for example, in the English Channel the content of

dissolved silica is being reduced to a rather low value during the height of the vegetative period of diatomaceous plankton.

After a water sample contained in a platinum dish, has been treated at boiling temperature with a strong alkali solution all suspended silicon and colloids (undissolved) are being transformed into a dissolved state with its overall content sometimes increasing manifold. This method is used for determining the presence of the undissolved forms of silica in sea water.

The material from investigations carried out in the Barents Sea and the Norwegian Sea in the period 1957/59 have provided evidence of the fact that in some areas the last traces of analytically detectable silica have entirely disappeared by the end of the vegetation maximum. On the other hand, the Bering Sea is known for its high content of dissolved silica. Such variety in silicon concentration in the northern seas attracts a researcher's attention. The analyses of the collected water samples for content of silica formed the basis of determining the chemical conditions for the primary production.

The 1958/59 investigations revealed that the amount of silicon, both dissolved and undissolved, present in the Norwegian and Barents Seas decreases towards east (Table 3). The same holds good for the Atlantic currents and for coastal and near-continental waters. Such distribution of dissolved silica was also observed in the upper photic layer up to 50 m, and in the subsurface layer from 100 to 500 m.

The concentration of undissolved silica was different in the western and eastern parts of the investigated area. The content of undissolved silica of the Atlantic currents was higher in the Barents Sea than in the Norwegian Sea. In the coastal and near-continental waters of the Norwegian Sea the content of undissolved silica both in the photic and subsurface layers was higher than in the waters of the western Scandinavian coast, in spite of the fact that the latter contains more river water discharge, as compared with the discharge of the Kola peninsula rivers.

The changes in silica content in the Norwegian Sea were followed during May/June and November/December. It was observed that the silica content decreases from spring/summer to autumn/winter (Table 4).

The average content of dissolved silica in the subsurface layer (100–500 m) of the Norwegian Sea is higher than in the photic layer lying above; still more is found in the deeper layers. However,

Table 3. Silica content in northern waters

Seas	Norwegian Sea				Barents Sea Western area				Barents Sea Eastern area			
	May—June				June—July				June—July			
	Si diss. mg at./l		Si undiss. mg at./l		Si diss. mg at./l		Si undiss. mg at./l		Si diss. mg at./l		Si undiss. mg at./l	
Atlantic waters												
0—50 m	5.70	20.6	22.07	79.4	5.34	10.1	47.70	89.9	—	—	—	—
100—500 m	8.19	20.0	32.93	80.0	5.70	4.71	116.41	95.3	—	—	—	—
over 1000 m	11.04	34.5	21.00	65.5	—	—	—	—	—	—	—	—
Local waters												
0—50 m	5.34	15.7	28.84	84.3	4.27	7.5	52.69	92.5	0.54	3.0	18.51	97.0
100—500 m	8.90	35.2	16.38	64.8	6.76	33.0	13.70	67.0	3.56	19.6	33.82	90.4
over 1000 m	11.04	24.8	33.46	75.2	—	—	—	—	—	—	—	—
Coastal near-continental waters												
0—50 m	4.61	14.9	26.52	85.1	2.49	14.3	14.95	85.7	—	—	—	—
over 100 m	8.54	15.7	45.92	84.3	4.27	50.0	4.27	50.0	—	—	—	—
Coastal (off Spitsbergen)												
0—50 m	3.20	18.0	14.60	82.0	—	—	—	—	—	—	—	—
over 100 m	4.27	17.5	20.29	82.5	—	—	—	—	—	—	—	—

Table 4. Seasonal changes of silica compounds in waters of the Norwegian Sea

Seasons	May—June				November—December			
	Si diss.		Si undiss.		Si diss.		Si undiss.	
	mg at./l	%	mg at./l	%	mg at./l	%	mg at./l	%
Atlantic waters								
0—50 m	5.70	20.6	22.07	79.4	5.16	20.8	19.76	70.2
100—500 m	8.19	20.0	32.93	80.0	6.41	21.5	23.50	78.5
over 1000 m	11.04	34.5	21.00	65.5	9.97	24.0	31.68	76.0
Local waters								
0—50 m	5.34	15.7	28.84	84.3	3.74	12.8	25.63	87.2
100—500 m	8.90	35.2	16.38	64.8	5.70	11.3	44.68	88.7
over 1000 m	11.04	24.8	33.46	75.2	8.54	36.7	14.77	63.3

Table 5. Distribution of silica in water layers of the northern seas

Seasons		May—June			
		Si diss.		Si undiss.	
		mg at./l	%	mg at./l	%
Photic layer					
Norwegian Sea	Atlantic waters	5.70	20.6	22.07	89.4
	Local waters	5.34	15.7	28.84	84.3
	Coastal near-cont. waters	4.63	14.9	26.52	85.1
Barents Sea	Atlantic waters	5.34	10.1	47.70	89.9
	Local waters	4.27	7.5	52.69	92.5
	Coastal near-cont. waters	2.49	14.3	14.95	85.7
Subsurface layer					
Norwegian Sea	Atlantic waters	8.19	20.0	32.93	80.0
	Local waters	8.90	35.2	16.38	64.8
	Coastal near-cont. waters	8.54	15.7	46.10	84.3
Barents Sea	Atlantic waters	5.70	4.7	116.41	95.3
	Local waters	6.76	33.0	13.71	67.0
	Coastal near-cont. waters	4.27	50.0	4.27	50.0
Deep layers					
Norwegian Sea	Atlantic waters	11.04	34.5	21.00	65.5
	Local waters	11.00	24.8	33.46	75.2

the distribution of undissolved silica by layers could not be traced with equal accuracy (Table 5).

The above data show that silica is actively involved in forming new organic substance of phytoplankton. The presence of colloid forms of silicon compounds in sea water and the rapid regeneration of silica during the process of decomposition of dead phytoplankton organisms supplies the photic zone with an extra source of assimilated compounds of silica.

M. V. FEDOSOV and I. A. ERMACHENKO

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International Investigations on Hydrographic Conditions in the Norwegian Sea, June 1959

(See Figures 6—9 in the Herring Section of this volume)

During the ship meeting in Seydisfjord, Iceland, in June 1958, the four countries Denmark, Iceland, Norway, and the USSR agreed to continue the joint investigations in the Norwegian Sea and Icelandic waters during June 1959. After the cruises had been completed the research ships "Professor Mesjatsev", "Johan Hjort", and "Dana" met in Thorshavn during the days of 29. June to 1. July. Dr. EINARSSON and Mr. HALLGRÍMSSON represented Iceland at the meeting.

During the meeting, diagrams were drawn of temperature distribution at 20 and 100 m depth in combination with phosphate distribution at 10 m. These diagrams, together with a station map are shown in the Herring Section of this volume (Figs. —).

A Herring Committee, a Plankton Committee, and a Hydrographical Committee were set up at the ships' meeting. Reports of these committees are given in this volume.

The hydrographic conditions were discussed at the committees' meeting and were compared with the conditions of previous years. In general, it was found that water circulation in the area investigated seemed to be stronger than in any year since 1954. Thus the water masses of both branches of the Atlantic Current, the Irminger Current and the Norwegian Current were warmer than usual. The

temperature of the Irminger Current off NW Iceland at 100 m was 2°–3°C higher than in 1958.

In the eastern part of the Norwegian Current off the Norwegian coast the temperature was about 0.5° higher than in 1958 and about 0.2° higher than in the warm year of 1954. The northernmost part of this current did not show any remarkable rise in temperature compared with recent years. Off Bear Island the western part of the Norwegian Current was colder and the eastern part of approximately the same temperature as in 1958. West of Bear Island there was a sharp front between the Norwegian Current and the cold water masses.

The waters of the East Icelandic Current and of the Jan Mayen branch of the East Greenland Current was considerably colder than usual. The mean temperature of the 0—50 m water layer of the Langanes/Jan Mayen section was about 1°C lower than in the years 1954/55 and 1957/58, and the eastward extension of the east Icelandic water as given by the 5° isotherm at 20 m depth, was wider than in any year since 1954, except in 1955 when a narrow tongue of cold water stretched further eastwards in a restricted area as a local phenomenon.

The ice border off Jan Mayen was situated extremely far eastward. Even at the beginning of June ice was observed east of Jan Mayen, a phenomenon not observed in several years, the year 1954 excepted.

In the distribution of phosphate and oxygen concentration the following features were of special interest:

Off the continental shelf of W Iceland, in the main branch of the Irminger Current an area with maximum concentration of phosphate and a minimum of oxygen was observed. Repeated surveys showed a north-eastward movement of this phosphate maximum and oxygen minimum in the course of the Irminger Current.

Between the Faroes and SE Iceland and in the Faroe-Shetland Channel high concentrations of phosphate were observed. A tongue of water with high phosphate values was stretching north-eastward from the Faroes. The factors producing these features are considered to be: (1) low stability of the upper water layers over the Faroe-Iceland Ridge, (2) a north-eastward transport of phosphate-rich water carried from this area by the Norwegian Current, and (3) strong mixing in the eastern boundary between the East Icelandic and the Norwegian Currents.

A. ALEKSEJEV, B. ISTOSHIN, W. PACHORUKOV,
P. MYRLAND, H. EINARSSON, F. HERMANN,
U. STEFÁNSSON

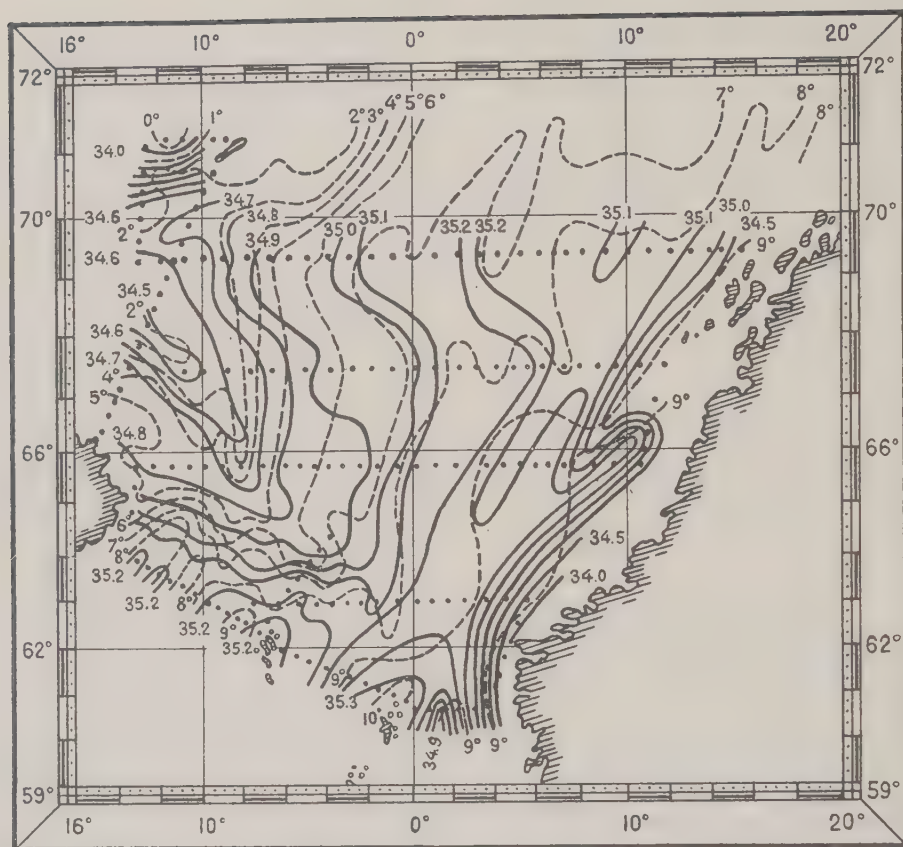


Figure 25. Location of stations (black dots) and distribution of temperature and salinity at the surface, 28. October to 13. December 1959.

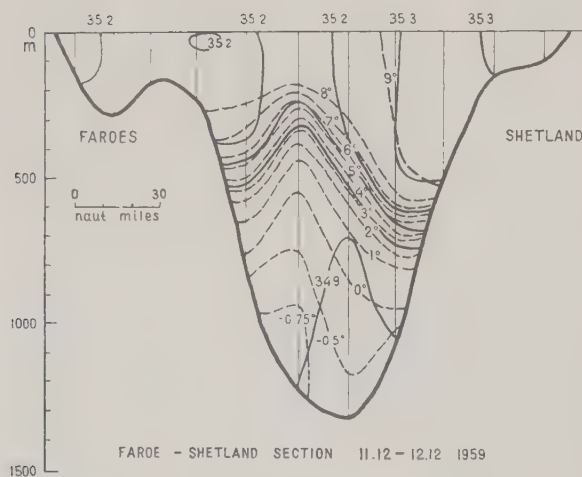


Figure 26. Faroe-Shetland section, 11.—12. December 1959; temperature and salinity.

Hydrographic Conditions in the Norwegian Sea, November—December 1959

(Figures 25-28)

In November/December, oceanographical investigations in the Norwegian Sea were carried out by Soviet R/V "Sevastopol". Figure 25 shows the location of stations and the distribution of temperature and salinity at the surface. As during the cruise the homothermous layer was developed sufficiently, the surface temperature is significant also for deeper layers: to 80—150 m in the region of the East Icelandic Arctic Current and, in Atlantic waters, to 200 m in the northern part of the region, and to 500 m in the southern part.

As compared with the same period in 1958, Atlantic water temperature was about 1°C higher in the layer 0—500 m in the northern and middle parts of the Norwegian Sea. In the section on latitude 63°N the temperature conditions of 1958 and 1959 were similar.

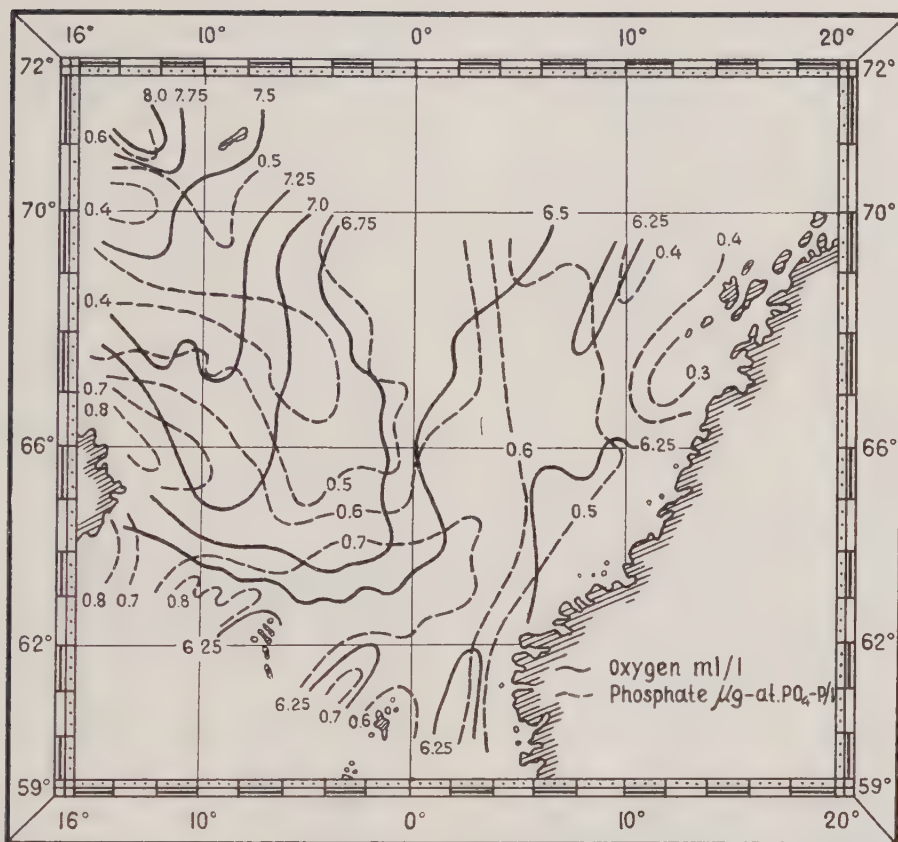


Figure 27. Dissolved oxygen and inorganic phosphate at the surface, 28. October to 13. December 1959.

Figure 26 shows the temperature and salinity distributions on the Faroe-Shetland section. Atlantic water (salinity higher than $35^{0}/_{00}$) transport calculation across the eastern half of the section gave a high value, namely, $46.12 \text{ km}^3/\text{hr}$ northwards against a southwards transport of $14.75 \text{ km}^3/\text{hr}$. The current velocities were calculated by the dynamic method; the zero level was the bottom. Such a great water transport apparently was connected with strong and settled southerly winds which predominated in the first ten-day period of December. On 23.—25. October 1958, the analogous transport calculated in the same way was considerably lower, namely, $17.16 \text{ km}^3/\text{hr}$.

A cold "tongue" of the East Icelandic Arctic Current was situated more to the north-west than usual, but not so far as it was in 1958. The temperature of the East Icelandic Arctic Current water in 1959 was lower than in 1958 and the maximum temperature lowering of 1°C was recorded in the area between latitudes 67° — 68°N . According to the

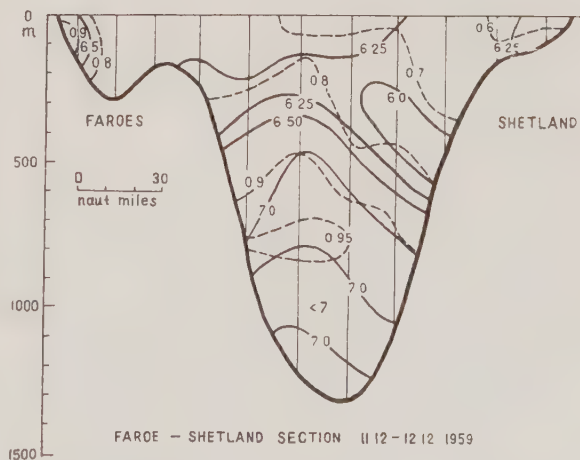


Figure 28. Faroe-Shetland section, 11.—12. December 1959; dissolved oxygen and inorganic phosphate.

salinity the East Icelandic Arctic Current in the same latitude extended very far eastwards. In the area north of the Faroe-Iceland Ridge the boundary between the East Icelandic Arctic and Atlantic waters is rather sharply defined.

In November/December the shoals of herring were in mixed waters between the Icelandic shelf and the western border of the East Icelandic Arctic Current, within temperatures of 4° – 5° C. At night the herring shoals were found in the homothermous layer, in the day-time, by vertical migrations, they sometimes descended into layers with temperature below 0° C.

In the area of the Norwegian Deep the bottom layer salinity was somewhat higher as compared with that of March/April 1958. Salinity below 34.90°_{00} was found in a limited area.

According to the data collected during the cruise of R/V "Sevastopol" and other observations it is possible to come to the conclusion that one of the peculiarities of 1959 was the increased intensity of the Norwegian and East Icelandic Arctic Currents. On account of this, Atlantic water was more than usually close to the continental slope of Norway, and the area of East Icelandic Arctic Current water was extended eastwards, its temperature declining.

The warming that began in December 1958 in Atlantic waters in the southern part of the region was recorded in the eastern branch of the Norwegian Current by the middle of 1959 in the latitude of Lofoten. By the end of the year it had extended more northwards and became conspicuous in the middle and western branches.

As observed by us the similarity of conditions in the southern part of the region in December 1958 and 1959 can serve as a sign of conservation of the higher intensity of the Norwegian Current in December 1959.

Figure 27 shows the distribution of dissolved oxygen and phosphate at the surface. The following zones are distinguished: (a) cold water of the East Icelandic Arctic Current with high oxygen content — more than 7.0 ml/l; (b) warm Atlantic water with low oxygen content — below 6.5 ml/l. An oxygen maximum value of more than 8.0 ml/l at the surface was recorded west of Jan Mayen and a minimum value of below 6.25 ml/l was observed north of the Faroes.

The oxygen values at the surface were below 100% saturation everywhere. The maximum value of 99% was recorded west of Jan Mayen, the minimum one of 95% was found north of the Faroes. Percentage saturation gradually decreased

downwards and in the bottom layer of the Norwegian Deep it was 83–84%.

At the surface, phosphate minimum values of 0.3 – 0.4 $\text{PO}_4\text{—P}$ $\mu\text{g-at./l}$ were observed in the waters of the East Icelandic Arctic Current and in the Lofoten area, and maximum values of 0.7 – 0.8 $\text{PO}_4\text{—P}$ $\mu\text{g-at./l}$ were recorded in Atlantic water in the southern Norwegian Sea.

The influence of the spring/summer photosynthesis process in the distribution of nutrients is conspicuous still in the uppermost productive layer. As compared with the data collected during the cruise of R/V "Sevastopol" in May, the concentration of phosphate and silicate in that layer decreased by 20–40%.

At the bottom of the Norwegian Deep the nutrient content was relatively high: phosphate at 0.97 – 1.13 $\text{PO}_4\text{—P}$ $\mu\text{g-at./l}$ and silicate at 12.10 – 14.24 $\text{SiO}_3\text{—Si}$ $\mu\text{g-at./l}$.

An interesting feature of the vertical distribution of dissolved oxygen, phosphate, and silicate in the Norwegian Sea, excluding the uppermost productive layer, is a gradual drop in the isolines of these elements from west to east and from north to south.

Figure 28 shows the vertical distribution of the dissolved oxygen and phosphate in the Faroe-Shetland section.

A. ALEKSEJEV, B. ISTOSHIN,
L. PONOMARENKO

Hydrography of the Faroe Bank Channel

(Figure 29)

L. H. N. COOPER's hypothesis (1) regarding the overflow of cold, deep sub-Arctic waters into the North Atlantic Ocean basin as of significance, possibly of fundamental significance, to the fisheries of north-west Europe as a whole, and his citation (2) of the Faroe Bank Channel as a probable route of such overflow, has brought this deep, narrow channel, shown by ROBINSON (3) in 1952, to be even deeper than was until then appreciated, into greater prominence. Further investigation of the hydrography and of the hydrodynamics of the channel med an integral part of the international investigation which took place in the month of June 1960, into the overflow phenomenon as this was manifest during the material period between the Faroe Islands and Iceland. STEELE (4), in the beginning of August 1958, found conclusive evidence of it on a restricted part of the submarine ridge connecting these two land masses, evidence which was totally lacking

• THE FAROE BANK CHANNEL •

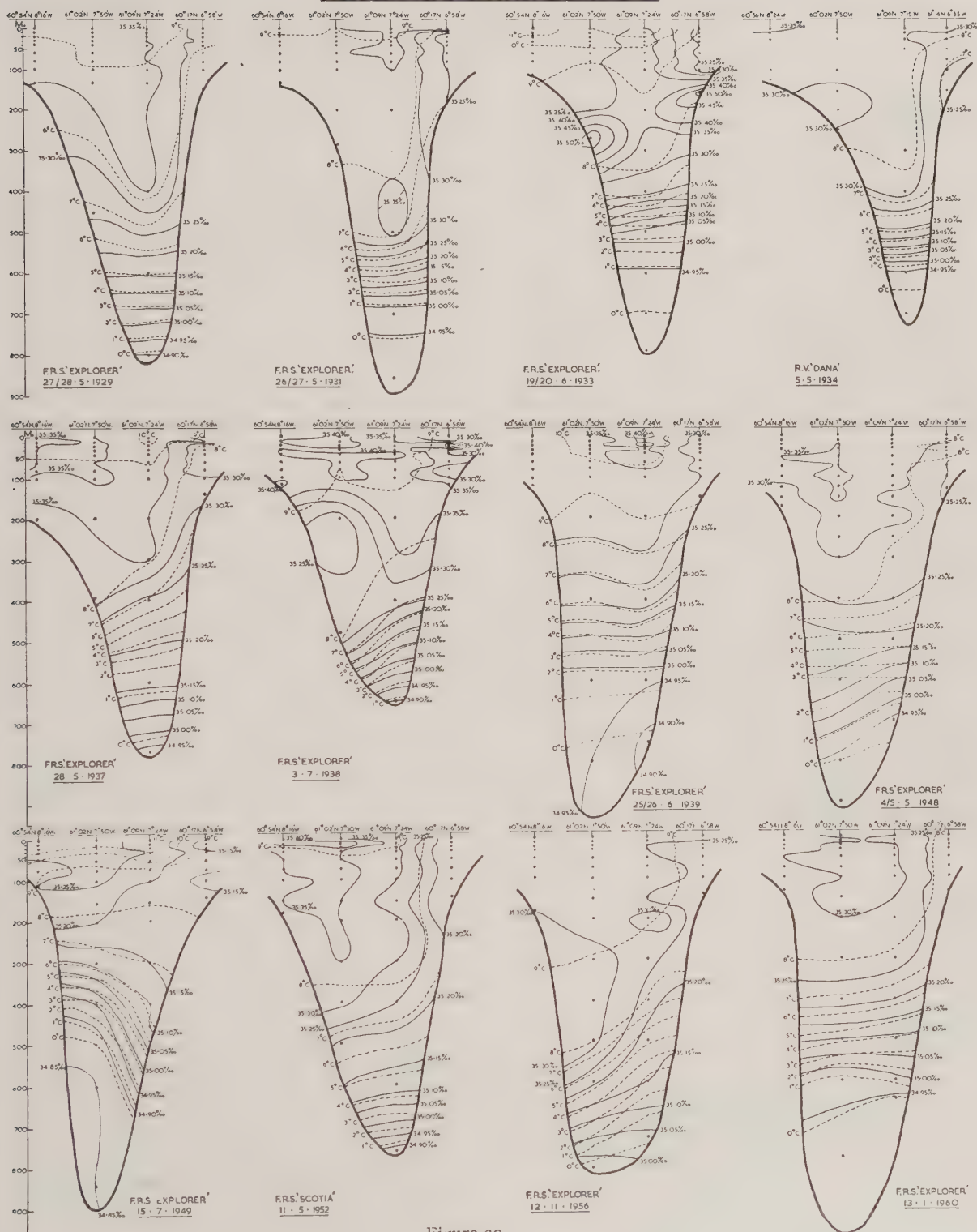


Figure 29.

some seven weeks later, thus tending to show that the phenomenon is an intermittent one, probably governed by internal wave dynamics in the southern reaches of the Norwegian Sea. This aspect of the problem was also investigated in June 1960.

Later, STEELE (5) has propounded that, by a less exacting standard of temperature particularly, the overflow is probably more or less constant, but it is still perhaps a moot point whether SEELE's relaxed standard of assessment of the overflow should be regarded as of real significance from the fisheries standpoint.

The purpose of this note is to assemble, graphically, the twelve short hydrographic sections athwart the channel, which have been worked by Scottish research ships and, in one instance, by the Danish research ship "Dana", between 1929 and 1960. Only two of these sections refer to winter months, namely, those of November 1956 and January 1960, the remainder having been traversed in the months of May, June and July. All of them except two, namely those for July 1938 and May 1952, denote sub-zero temperature water in the bottom of the channel, and all of them except three, namely those for July 1949, May 1952, and November 1956, by their minimum salinity registrations near bottom, denote bottom Norwegian Sea water in this locality, in prolongation no doubt of the deep water of the Faroe-Shetland Channel. The three exceptional sections are interesting in that one is in marked contrast to the other two. In November 1956 the bottom-most recorded salinity in over 800 metres, was 34.97^{0}_{00} , which is characteristic of mixed oceanic and bottom Norwegian Sea water. In the other two cases, that is, in July 1949 and May 1952, salinities of 34.85^{0}_{00} between 550 and 900 metres, and of 34.88^{0}_{00} in

just under 800 metres, respectively, denote intermediate Arctic water as pervading the bottom of the Faroe-Shetland Channel and its prolongation through the Faroe Bank Channel at these periods, a phenomenon already remarked upon in the major study of the Faroe-Shetland Channel reported upon by the writer (6).

There can be little question that in all cases, with the possible exception of November 1956, these bottom waters of the Faroe Bank Channel were coursing north-westward as was demonstrated by a series of bottom current measurements by the Carruthers "Pisa" equipment in 1958 (7).

J. B. TAIT

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B. Near Northern Seas

Hydrographic Conditions in the North Sea 1959

(Figures 30–32)

In connexion with herring and sand-eel examinations R/V "Dana" has made hydrographic observations in the southern North Sea. Two cruises, one in May–June and one in September were undertaken, and the results seem to indicate a temperature development similar to that of previous years. Figures 30–32 show the international R-section, where the development of the discontinuity layer is clearly defined.

The temperatures were rather normal in spring, whereas surface temperatures were above and bottom temperatures below normal in the autumn. This is doubtless due to the warm and calm summer.

KNUD P. ANDERSEN

Hydrographic Surveys of the Northern North Sea 1959

(Figures 33–35)

From the 1959 surveys, three have been selected as of general interest. Three less extensive surveys were made later in the year, and similar data charts can be supplied if required.

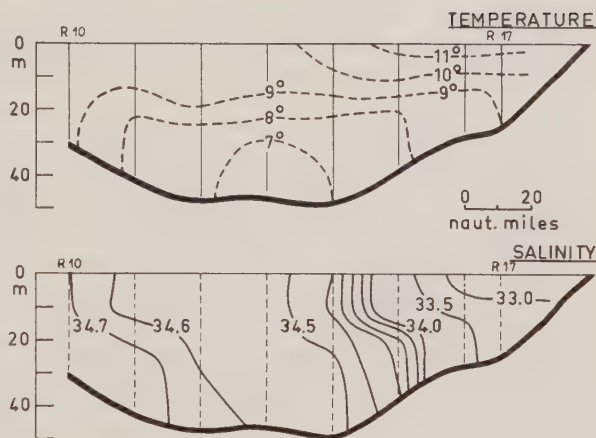
The general features seem to be as follows.

(a) *Temperature*: Surface and deep temperatures during spring and summer were not greatly different from normal, the deep values being about $\frac{1}{2}^{\circ}\text{C}$ above normal. After August surface temperatures declined more slowly than usual, and autumn values were about 1°C above normal.

(b) *Salinity*: This is expressed as D.C.I. (CRAIG, this journal Vol. XI, pp. 37–41). Salinity was unusually high at the most northerly boundary of the North Sea. There was no very striking invasion of this water, and the modest deep inflow apparent in Figure 35 is confined to the central region in about 2°E longitudes.

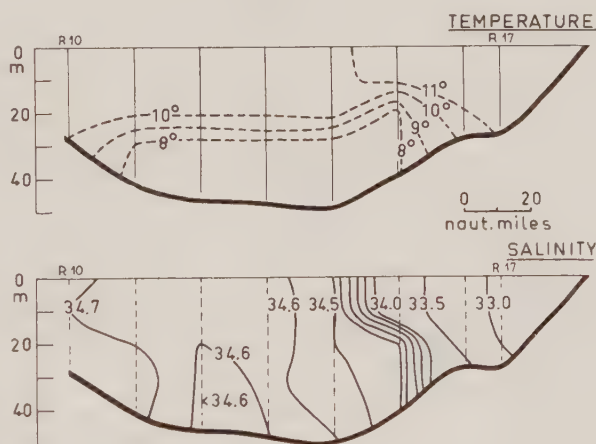
(c) *Water movements*: As in 1958 the circulation was extremely slow, judged by the evidence of drift indicators.

R. E. CRAIG



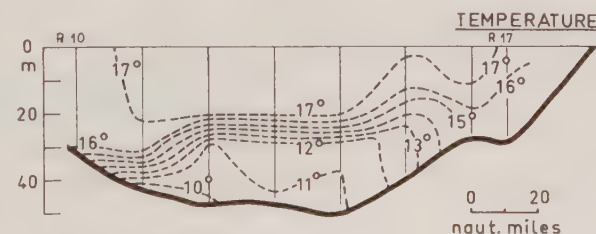
R-SECTION, 21.5–22.5. 1959

Figure 30. R-section, temperature and salinity, 21.5–22.5 May 1959.



R-SECTION, 2.6–3.6. 1959

Figure 31. R-section, temperature and salinity, 2–3 June 1959.



R-SECTION 2.9–4.9. 1959

Figure 32. R-section, temperature, 2–4. September 1959.

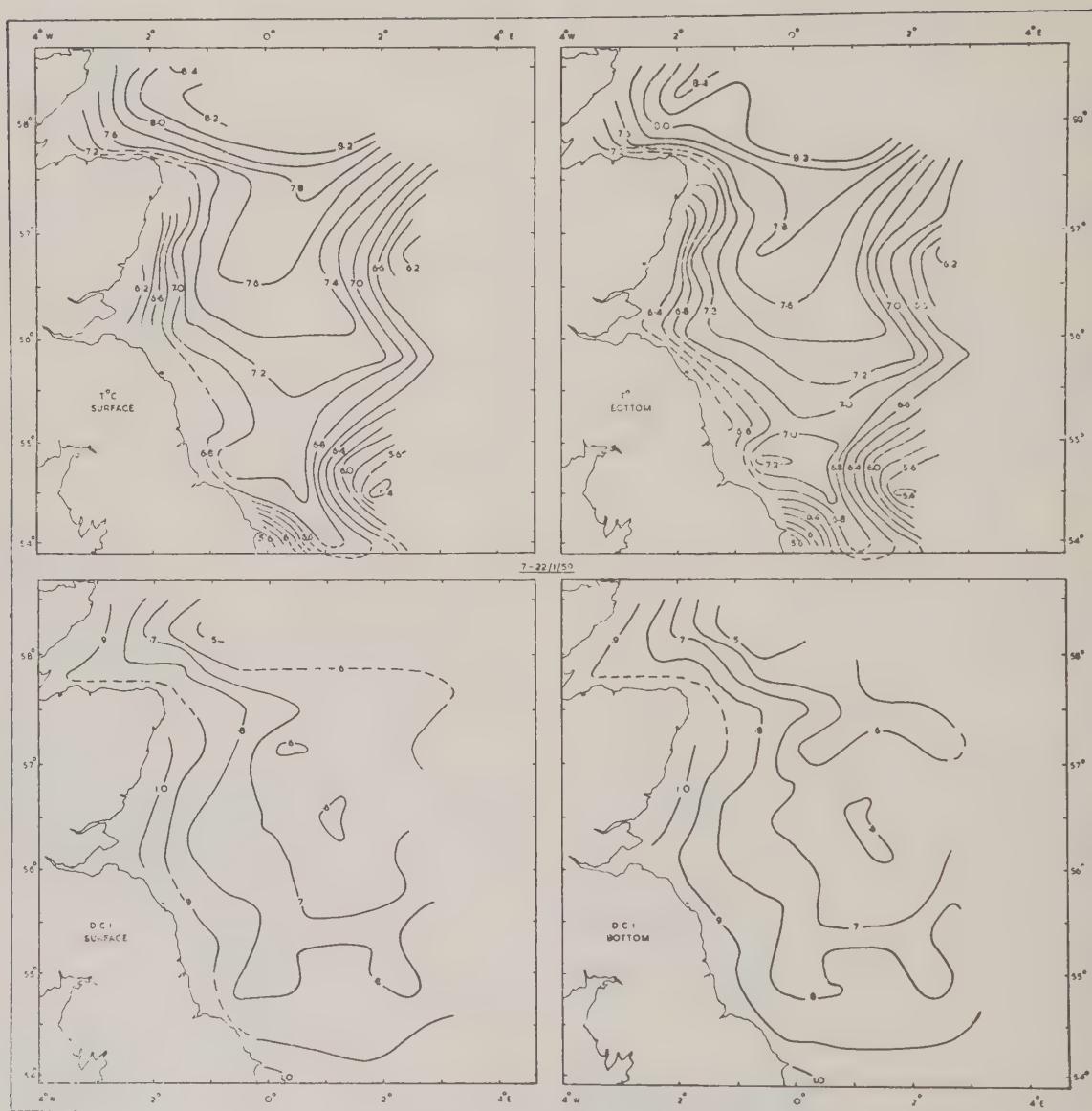


Figure 33. Temperature and salinity (expressed as D.C.I.)
in the region east of Scotland, 7.—22. January 1959.

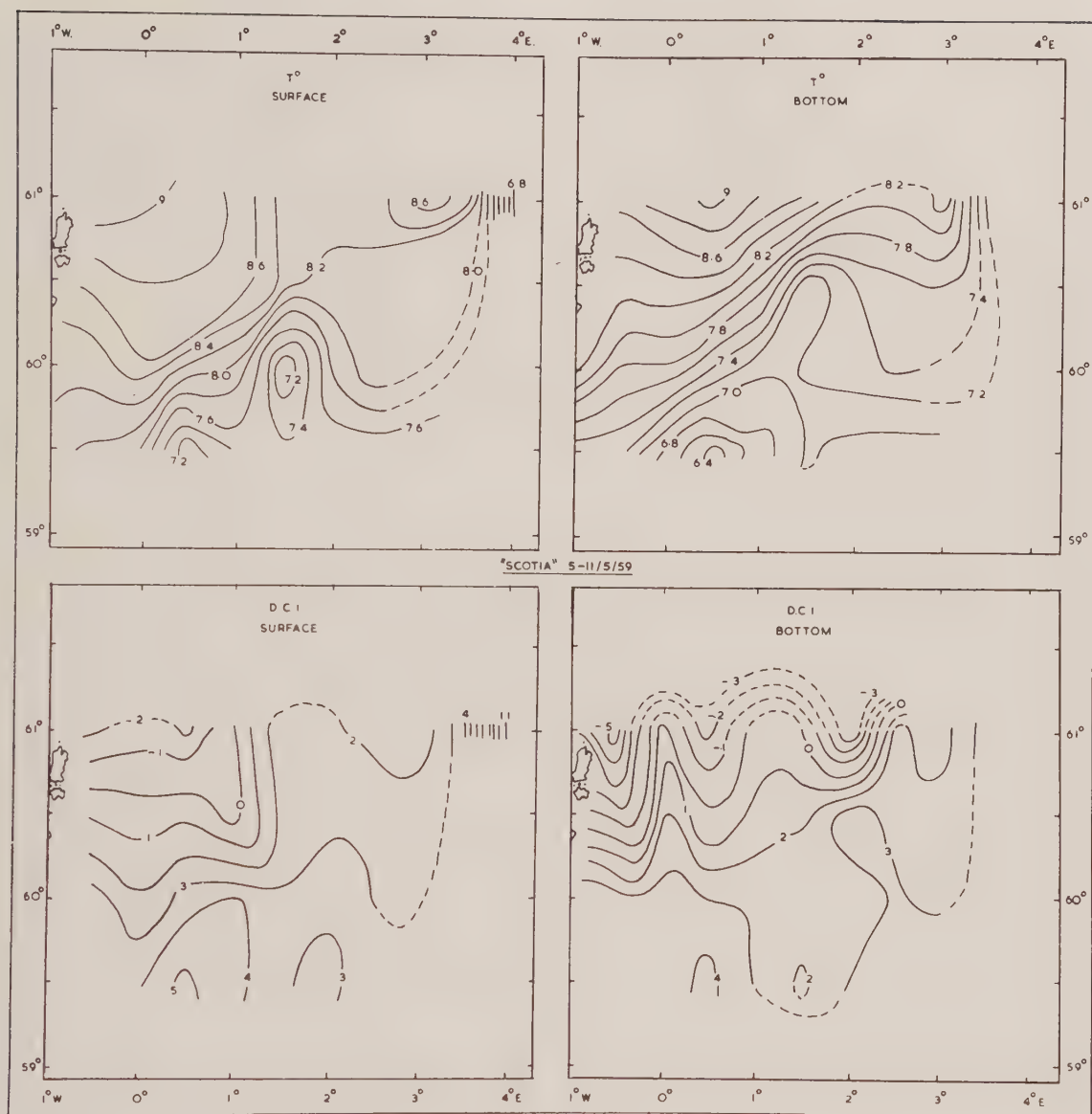


Figure 34. Temperature and salinity (expressed as D.C.I.)
in the Shetland region, 5.—11. May 1959.



Figure 35. Temperature and salinity (expressed as D.C.I.)
in the northern North Sea, 5.—21. July 1959.

The Distribution and Layering of Water Masses in the North Sea during June/July 1959

(Figures 36–38)

Hydrographic investigations were carried out in the North Sea by the fishery research vessel "Anton Dohrn" from 23. June to 23. July, 1959. The work included serial and bathythermographic observations at 220 stations. The station net is considered to be sufficient to obtain a reliable picture of the temperature and salinity pattern for the bottom water layers (Figs. 36 and 37). The course of the temperature section of Figure 38 is indicated in Figure 37.

Horizontal distribution of near-bottom waters

The chart of the salinity pattern (Fig. 37) shows five bodies of water of different origin: the Atlantic water, intruding into the North Sea between the Orkneys and the Norwegian coast, is split up into two tongues at 58°N and 3°30'E. The 35⁰/₀₀ isohaline of the western Atlantic water tongue almost coincides with the 0-meridian at 55°40'N and runs approximately 15 sm north of the Dogger Bank. The English Channel water with a relatively high salinity is defined by the 34.5⁰/₀₀ isohaline. The North Sea water itself is not only subject to the influence of the alien Atlantic water masses, but also to those of the continental and British coastal waters and is, therefore, a typical mixed water body.

The temperature pattern (Fig. 36) reveals considerable horizontal temperature differences especially in the Dogger Bank region, in offshore areas of the continental coast, and at the western slope of the Norwegian Deep. An extensive cold water body, defined by the 7.5°C isotherm, occupies the middle of the northern and central North Sea. It is distinguished as winter water preserved under the temperature discontinuity layer which hampers the vertical heat exchange. The limitation of the cold bottom water is discontinued between 57° and 58°N. The 7°C isotherm encloses two cold water cores which reveal within their centres temperatures as low as 6.1°C. At the southern end of a large cyclonic eddy in the northern North Sea,

warm and well mixed water masses from the Scotch coast are transported eastwards and intrudes far into the cold bottom water.

Layering of the water masses

The formation of thermic layering depends upon wind-produced turbulences, heat transformation at the sea's surface, and turbulences in the bottom layers. Since both turbulence effects are constant when considered over a long period of time, one can expect rather similar layering conditions each summer. On examining the sub-layer, four typical regions can be distinguished (Fig. 38):—

1. In the northern North Sea the water masses of the sub-layer are thermically stratified. Since the tidal current is rather weak here, the tidal turbulence is limited to a thin layer near the bottom. North of station 3382 the layering can maintain its oceanic character. The cold bottom water situated under a temperature discontinuity layer approximately 25 m thick, extends to more than 60 m.

2. In the central part of the North Sea the tidal currents are stronger, and hence the vertical mixing processes are more intensive within the sub-layer. The cold water body, about 30 m thick, is separated from the overlying water masses by an intermediate layer some 15 m thick.

3. North and south of the Dogger Bank the mixing processes of the tidal currents reduce the temperature discontinuity layer to 4 m. On the Dogger Bank itself the discontinuity layer bears the character of an abrupt limitation area.

4. The mixing zone of the southern North Sea commences south of station 3309. Tidal current velocities of 50 cm/sec. are here, according to our experience, sufficient to prevent stratification.

The vertical mixing processes play an important part in the field of causal relations between chemical and biological phenomena. The variation of the pattern from place to place deserves special attention with regard to hydrographic-fishery-biological investigations.

E. ROGALLA

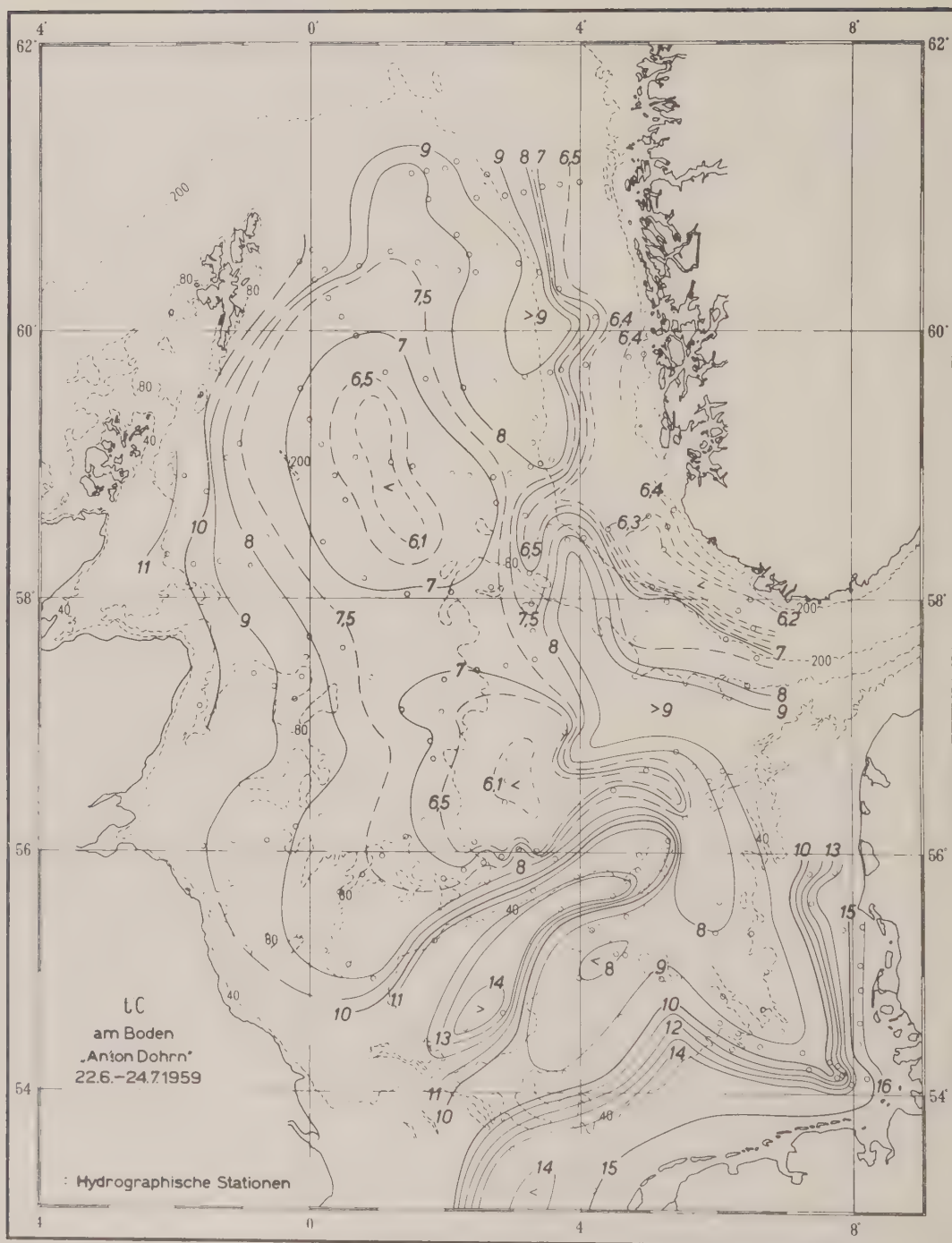


Figure 36. Bottom temperatures in the North Sea in June/July 1959.

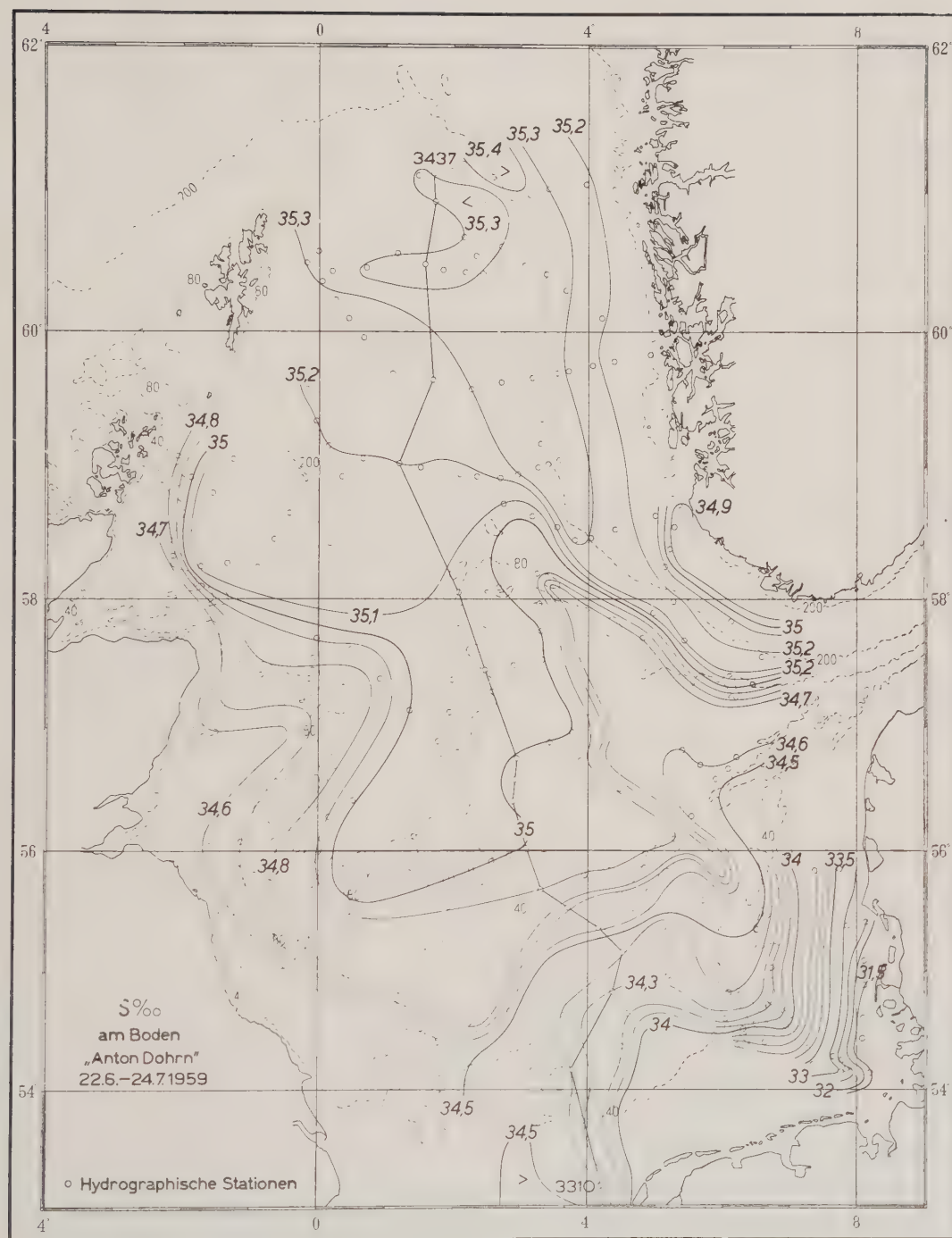


Figure 37. Bottom salinities in the North Sea in June/July 1959

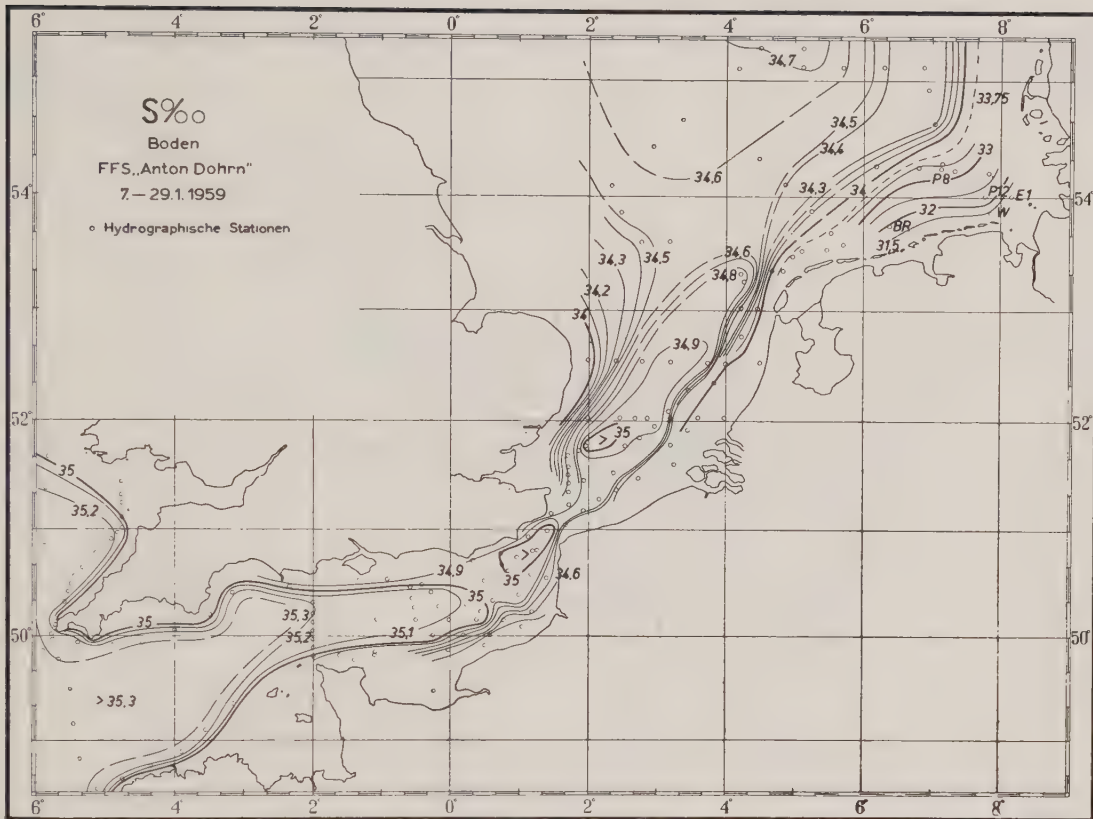


Figure 40. Bottom salinities in the southern North Sea and the English Channel in January 1959.

Hydrographic Conditions in the Southern North Sea and the English Channel in January 1959

(Figures 39–40)

The fishery research ship "Anton Dohrn" worked 187 hydrographical and biological stations during a cruise in the North Sea and the English Channel from 5.—30. January 1959. Some hydrographical results are presented in this paper; they are depicted in two diagrams. The distribution of temperatures and salinities, and the positions of the stations are given in Figures 39 and 40. The whereabouts of English Channel water and water from the central North Sea, both comparatively warm and with high salinity values, as well as of

continental and British coastal water, both comparatively cold and of low salinity, can be studied from these charts.

The considerable horizontal differences contrast to the vertical uniformity of the water masses. Though the hydrographical pattern refers to bottom water, it is valid for the period of observation for all depths in the area of investigation. Phenomena of vertical layering could only be observed in a small strip along the Dutch coast and in the Seine Bight. The track of the pelagic fish fry is determined by the direction which the water masses take in spreading. The direction of spreading of the water bodies can be determined by following their cores.

E. ROGALLA

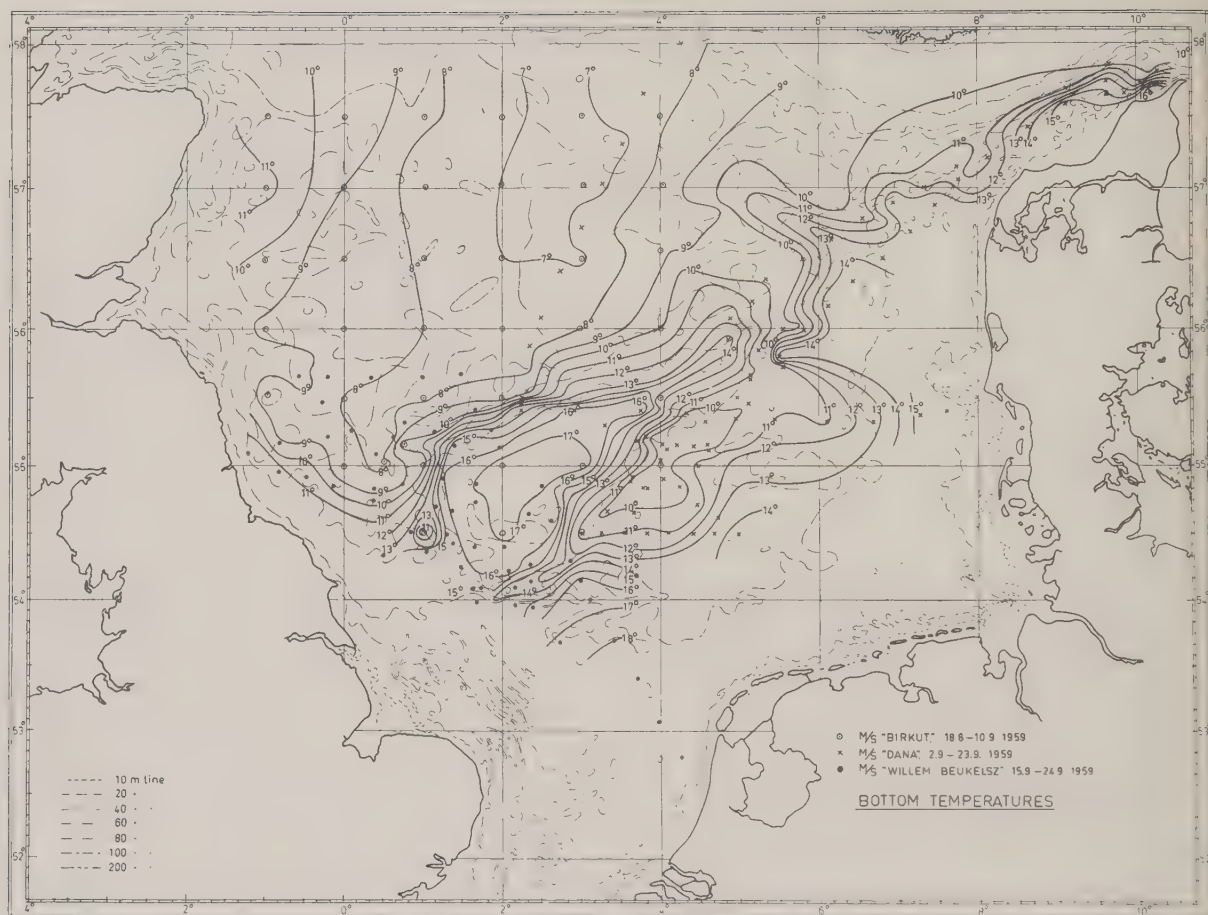


Chart 1. Bottom temperature between 18. August and 24. September 1959.

Hydrographic Conditions in the Southern North Sea in August/September 1959

(Charts 1 and 2)

In August and September 1959 the research vessels "Birkut" (Poland), "Willem Beukelsz" (Netherlands), and "Dana" (Denmark) made overlapping cruises in the southern North Sea. It was therefore agreed to publish a joint survey map of the hydrographic conditions near the bottom.

The observations fit well together and in Charts 1 and 2 bottom temperatures and bottom salinities

respectively, are shown (R/V "Dana" made only temperature observations). The temperatures north of Dogger Bank and on the bank were high, approximately 2°—3°C above normal, whereas the temperatures on the Bløden Ground were low, approximately 2°—3°C below normal. The stratification of the water masses in the Bløden area was thus very stable, and this may be seen as a consequence of the warm and calm summer. The salinity in the area investigated was probably about normal.

J. FILARSKI, K. H. POSTUMA,
and K. P. ANDERSEN

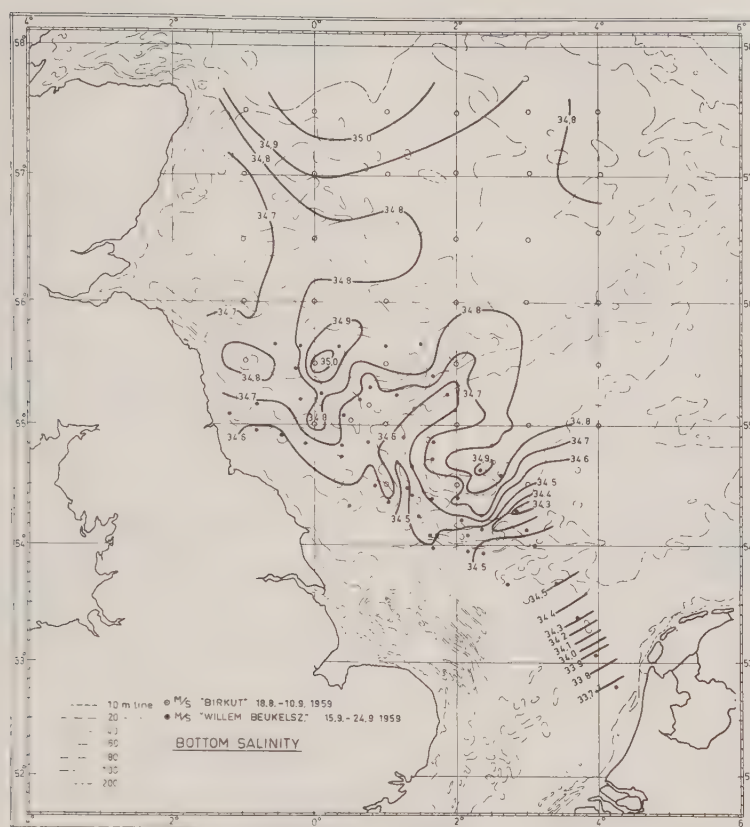


Chart 2. Bottom salinity between 18. August and 24. September 1959.

Hydrographic Conditions in the Southern and Central North Sea in July 1959

(Figures 41-46)

Water samples were collected, and temperature observations were made at 95 stations in the North Sea during a cruise of the Netherlands fishery research vessel "Willem Beukelsz", from 13. July to 1. August 1959. In addition, 21 B. T. records were obtained. These observations have been supplemented by data on surface salinities, collected on the regular shipping routes between the Netherlands and Great Britain in the same period, and further by data on salinities and temperatures in the bottom layers, collected by the "Willem Beukelsz" in the German Bight and south-west of the Dogger Bank from 1. to 8. July. The results are shown in Figures 41-46.

During this period wind force was predominantly 5 Beaufort or less. Only in the beginning of the cruise the wind force was over 5 Beaufort, whereas the wind force increased sometimes during showers in the last few days of the cruise.

Surface temperatures were in the second half of July some 1° to 2.5°C higher than the climatological mean value for this month. The chart of surface salinities (Fig. 42) reveals high values, relative to the mean, in the area north of the Dogger Bank. Remarkable is an area with high salinities south of the Outer Silver Pit. An observation made during the previous cruise of the "Willem Beukelsz" revealed here a thin layer of water, some 3 m thick only, on top of water with a salinity some 0.3‰ lower.

It is assumed that the high values in the Southern Bight were a consequence of the dry spring and summer of 1959, and of a reduced admixture with river water.

Contrary to these high salinities are the low salinity values in the area of the German Bight. These may have been brought about by poor mixing with deeper water layers, resulting from considerable heating of the surface layers in a period with limited wind speeds.

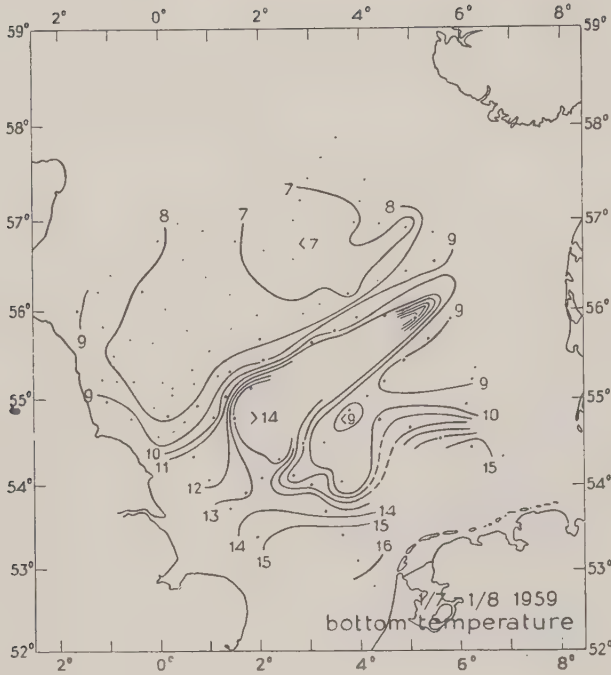


Figure 41. Bottom temperatures.

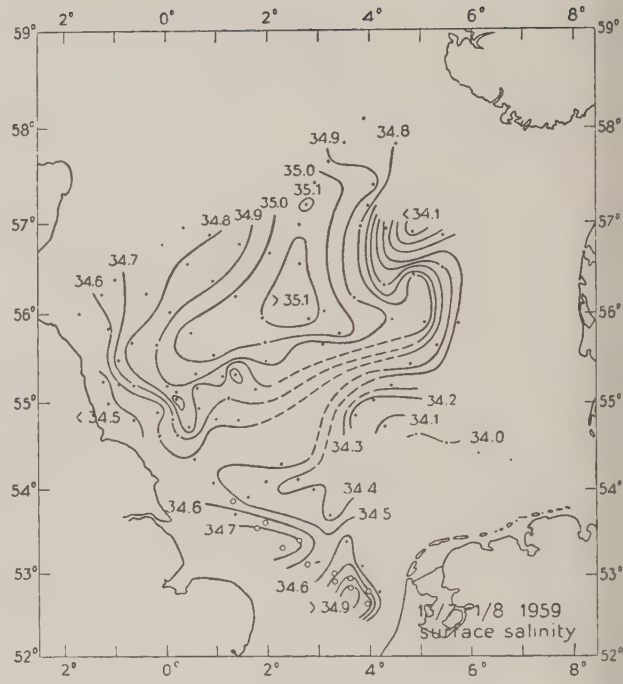


Figure 42. Surface salinity. Salinity observations of shipping routes are denoted by open circles.

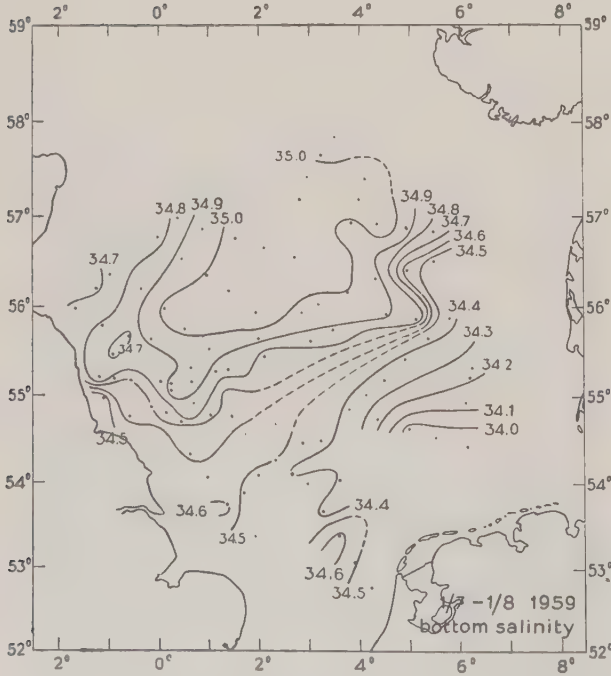


Figure 43. Bottom salinity.

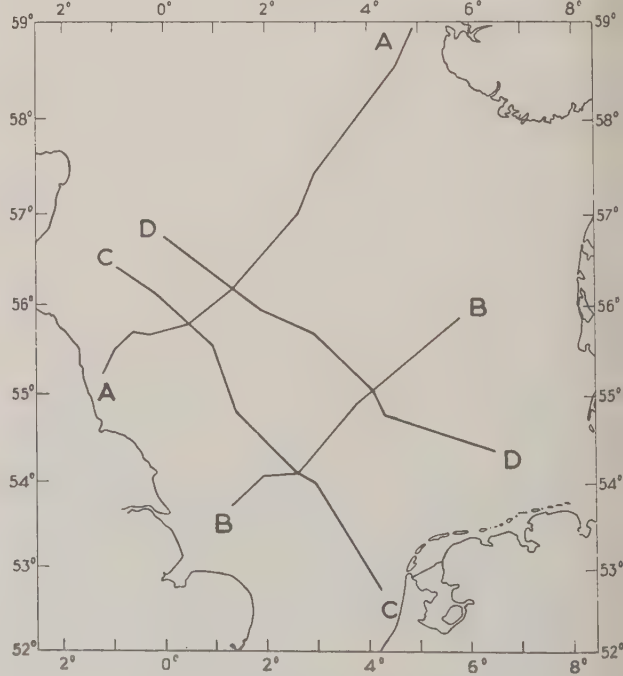


Figure 44. Courses of the sections.

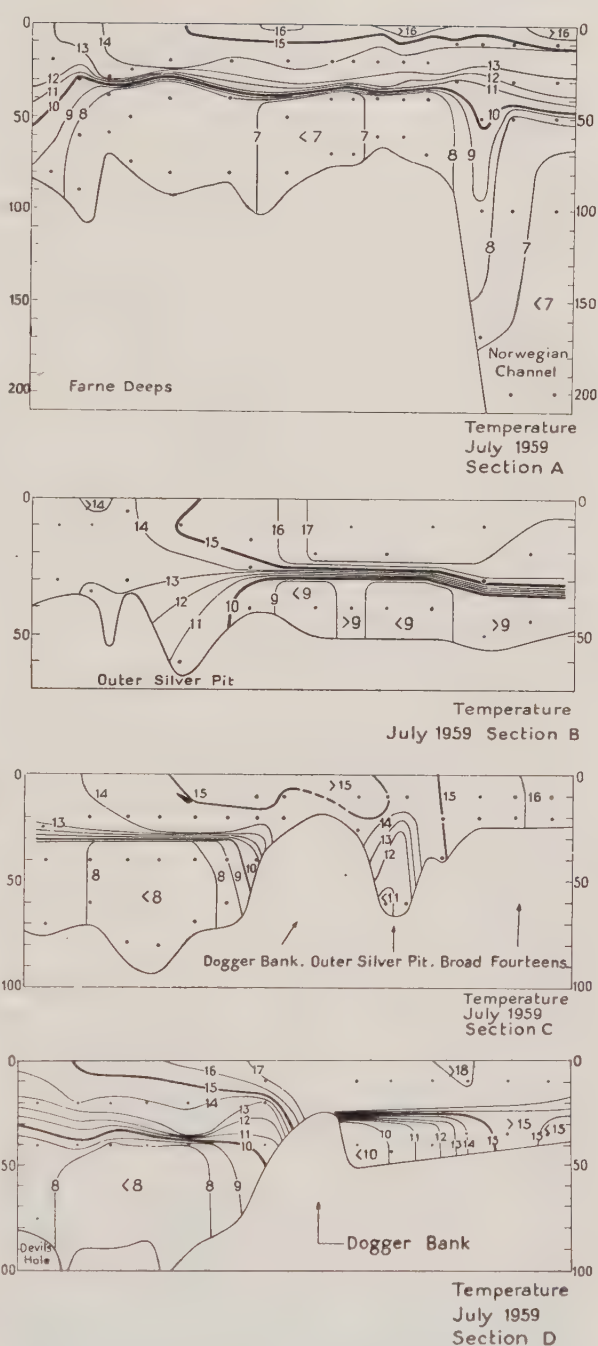
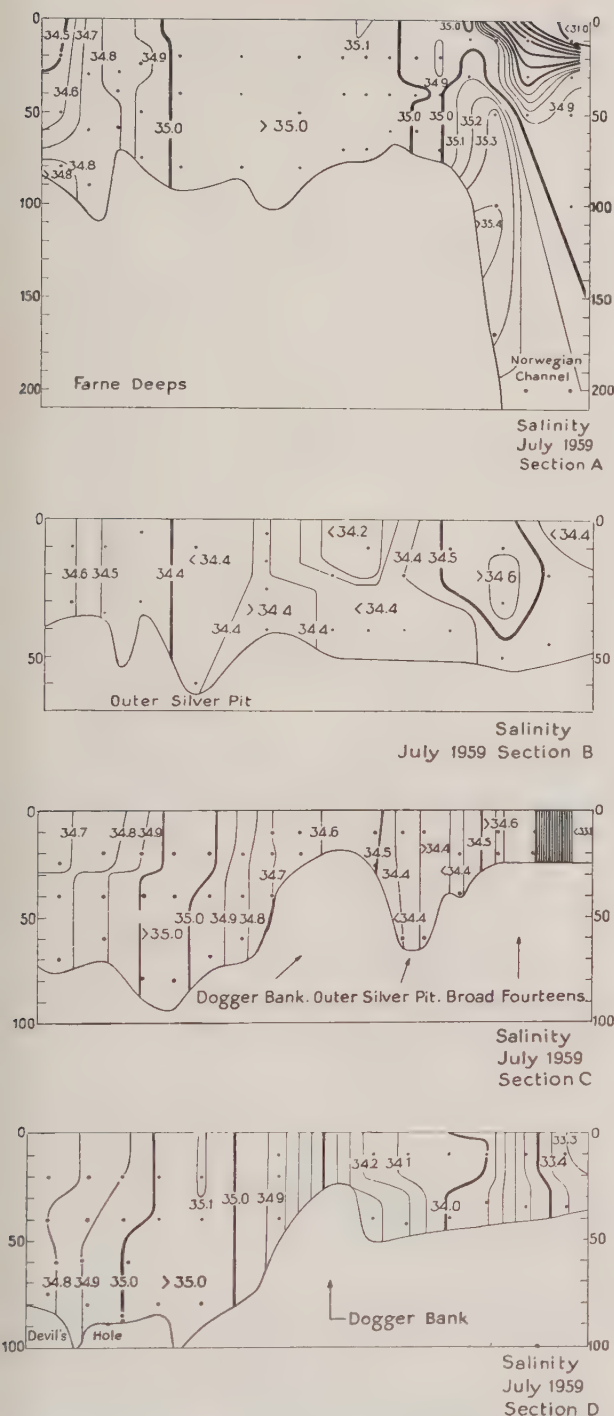


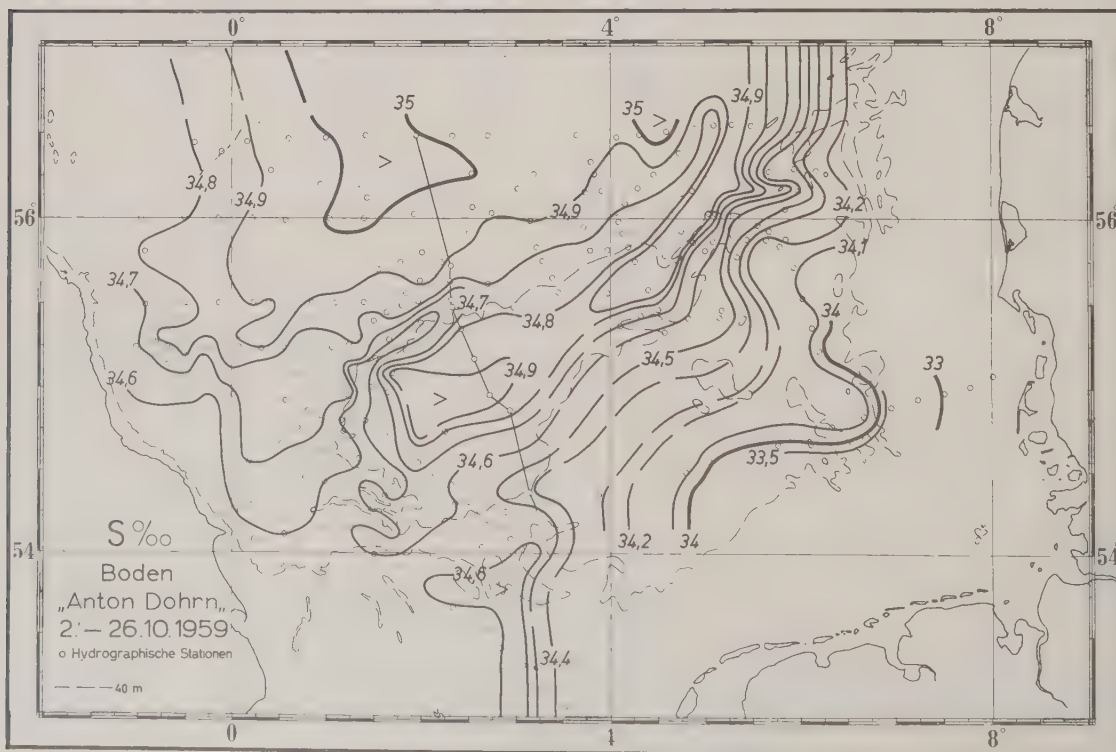
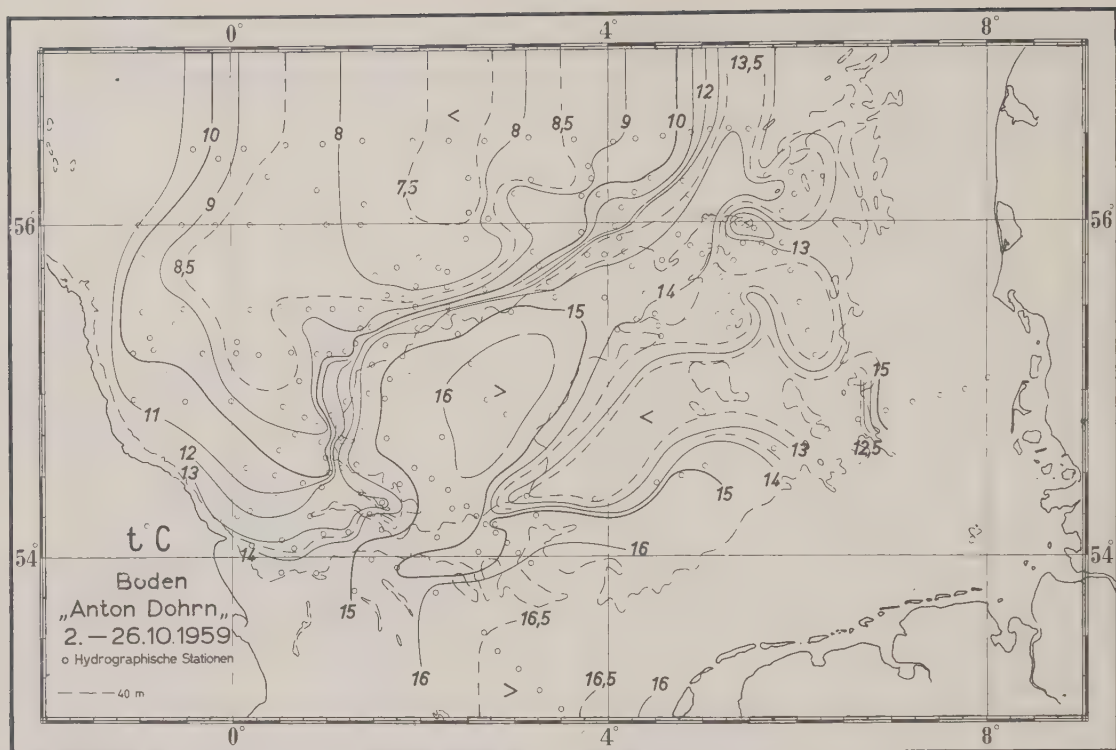
Figure 46. Temperatures on the sections A, B, C, and D. The horizontal scale is not the same for the different sections.

Figure 45. Salinities on the sections A, B, C, and D. The horizontal scale is not the same for the different sections.

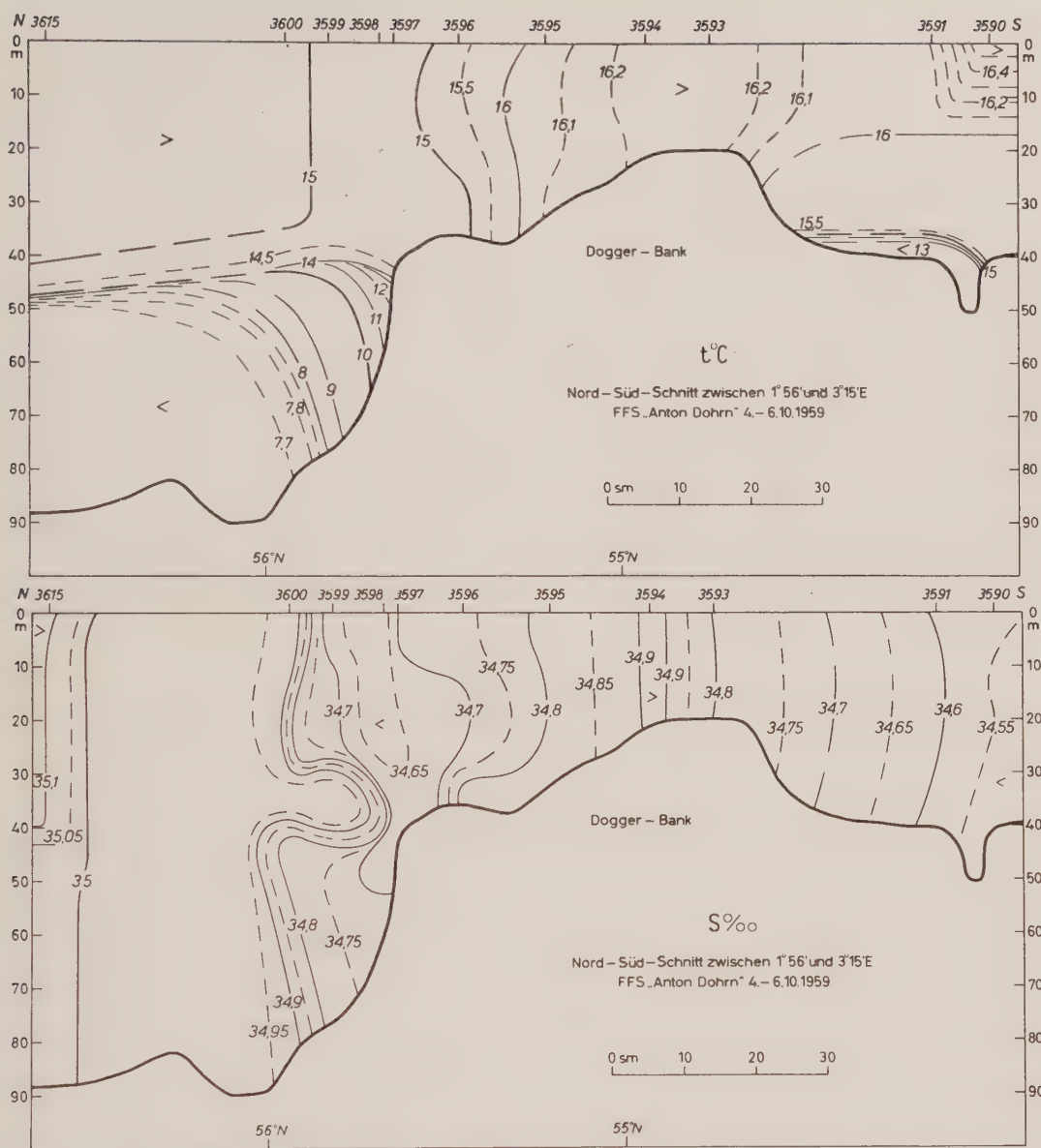
Compared with other years the bottom temperatures were on the whole rather high, whereas

bottom salinities were rather low. This was especially the case in the region south of the Dogger Bank.

L. OTTO, K. H. POSTUMA,
and J. J. ZIJLSTRA



Figures 47 and 48. Bottom temperatures and salinities in the Dogger Bank region in October 1959.



Figures 49 and 50. Temperatures and salinities on a northsouth section across the Dogger Bank between $1^{\circ}56'$ and $3^{\circ}15'E$. Observations made October 4—6, 1959.

Hydrographic Conditions in the Dogger Bank Region in October 1959

(Figures 47—50)

The fishery research ship „Anton Dohrn“ carried out a cruise in the central and southern North Sea from 1. to 28. October, 1959. The course of the route had a bearing on fishery biological work, which framed the planning of the cruise. The hydrographic programme comprised 241 stations for surface, bottom, serial, and bathy-

thermographic measurements. 680 water samples were collected for salinity determinations. The observations of temperature and salinity form the basis for conclusions on the extent of the influence of these exogenic factors on the distribution and route of herring swarms and of other food fish. Some hydrographic results are given in Figures 47—50.

The distribution of temperature and salinity in the bottom layers, and the position of the stations

are shown in Figures 47 and 48. Figures 49 and 50 present the vertical distribution of temperature and salinity. The profile of the north-south section is drawn in Figure 50.

Three water masses of different origin can be discerned on the salinity pattern. The water of the North Sea is located between the cold Atlantic water of high salinity (S_{00}^0 max. 37.07; $t^{\circ}\text{C}$ min. 7.28°) and the coastal water of the continent ($< 34.0^0_{00}$) and comprises the largest part of the area investigated. North of the south-west Patch and on the Tail End, water of a high salinity, over 34.9^0_{00} , is located which intrudes into the water body of the North Sea. The temperature pattern (Fig. 47) reveals an extensive warm water body on the East Bank (max. 16.22°). South-east of the Coffee Soil the minimum temperature of the North Sea water was 11.33°C. The cold bottom water body, enclosed within the 11.5° isotherm, was found on 24. October, located under a discontinuity layer of 1 m thickness, which separated it at a depth of 45 m from the surface layer with temperatures of

approximately 13.72°C. In Figure 49 a thermocline of 8 m thickness can be distinguished at a depth of 41 m north of the Dogger Bank. On the Dogger Bank the water masses are not stratified, since the vertical turbulence has a grip on the whole water column. North of the Cleaver Bank a thermocline of approximately 2 m thickness was observed at a depth of 35 m. It separates the bottom water with temperatures below 13°C from the warm surface layer with temperatures above 16°C. The vertical temperature distribution pattern differs from the salinity pattern.

From 17. October the area investigated was under the influence of gales, which temporarily reached hurricane force. The horizontal distribution of the water masses as well as the vertical layering changed rapidly. Therefore, a synoptical pattern for the whole area investigated cannot be given. The considerable distance between the stations south-east of the Dogger Bank makes a correct interpretation of the local situation difficult.

E. ROGALLA

Table 6. Mean values of surface temperature at fixed positions on the Hamburg—Hull route

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Year	Position I; 54°09'N, 07°32'E											
1957	5.3	4.6	5.5	7.2	9.0	13.3	16.9	16.8	14.9	13.2	9.9	7.3
1958	5.1	4.5	3.3	(7.5)	8.0	12.8	15.3	16.7	17.3	15.7	11.8	8.2
1959	5.9	4.4	4.9	7.3	9.4	13.0	16.6	18.2	16.8	14.3	10.2	8.0
	Position II; 54°18'N, 06°12'E											
1957	5.5	5.6	6.0	7.6	9.3	13.2	16.0	17.1	14.9	13.6	9.8	7.8
1958	5.5	4.2	4.7	(4.8)	8.4	14.1	15.7	16.4	16.8	15.4	12.1	9.1
1959	5.4	4.2	5.0	7.0	9.2	12.6	16.3	18.1	16.7	14.8	11.0	8.8
	Position III; 54°19'N, 05°21'E											
1957	6.2	5.8	6.3	7.5	8.6	13.3	16.0	17.0	15.2	13.5	9.9	7.7
1958	5.9	4.6	4.6	(4.9)	7.5	12.8	15.5	16.2	16.7	14.6	12.0	9.1
1959	5.7	4.8	5.4	6.6	10.2	12.7	16.7	18.0	17.1	14.7	10.7	9.4
	Position IV; 54°10'N, 04°26'E											
1957	(6.2)	5.8	6.2	7.4	8.9	13.7	16.1	16.7	15.2	13.9	10.4	8.1
1958	6.4	5.3	4.6	(6.8)	8.0	12.3	15.3	16.1	16.7	14.2	12.1	9.7
1959	7.3	5.4	5.4	7.1	9.9	13.4	17.1	18.1	17.2	15.0	11.0	9.3
	Position V; 54°00'N, 03°32'E											
1957	(6.3)	6.0	6.3	7.5	8.7	13.1	15.6	16.2	14.7	13.2	10.2	8.4
1958	6.4	5.2	5.4	(7.0)	8.0	12.1	15.4	15.7	16.1	14.3	11.5	9.1
1959	6.9	5.6	6.2	7.0	9.9	13.6	16.9	18.1	17.4	14.9	10.7	8.9
	Position VI; 53°53'N, 02°43'E											
1957	(6.2)	6.2	6.3	7.4	8.8	12.8	15.3	16.0	14.6	12.9	10.3	8.3
1958	6.8	5.1	5.8	5.7	7.6	11.3	14.7	14.8	15.0	13.1	11.3	9.3
1959	6.8	5.5	6.0	7.6	9.8	13.3	15.5	17.2	17.3	15.5	10.8	9.2
	Position VII; 53°45'N, 01°54'E											
1957	(6.1)	6.2	6.5	7.3	8.9	12.1	14.5	15.2	13.7	13.2	9.8	8.4
1958	6.5	5.2	5.3	(5.7)	7.7	10.2	13.3	13.9	14.1	13.1	11.0	9.3
1959	4.8	6.0	5.7	7.2	9.5	12.8	15.4	16.2	17.1	14.6	10.0	8.8

**Means and Anomalies of Temperature and Salinity
on the Hamburg—Hull Route in 1959**

(Figures 51–52; Tables 6–9)

German commercial vessels continued observations in the surface layers for the German Hydrographic Institute in the years 1957 to 1959, inclusive. Again, routine observations were made from moving ships at seven positions¹⁾. Temperature and salinity observations collected over the period 1957/1959 have been expressed as far as possible as monthly means (see Tables 6 and 7). In addition, monthly anomalies in reference to the period 1902 to 1928²⁾ have been computed for the entire period 1953/59. These deviations from the long-term means (see Tables 8 and 9) give an insight into the monthly variation of the heat and salt budgets in the surface water of the southern

¹⁾ Ann. Biol., 13 (1956), pp. 76–78, 1958.

²⁾ Bureau du Conseil: Atlas de température et salinité de l'eau de surface de la Mer du Nord et de la Manche. Copenhague 1933.

North Sea. The quarterly deviations of the temperature means (Fig. 51) show that the quarters VII/IX and X/XII of the year 1955, X/XII of 1958, and the two last quarters of 1959 were abnormally warm. On the other hand, the summer of 1954, and almost the entire year 1956 were abnormally cold. The average temperature in 1957 was about normal throughout the year. In connexion with the quarterly deviations of the temperature means the average salinity in the southern North Sea was relatively low during the second half of the year 1955, and in the German Bight during 1956 (Fig. 52). 1957 and 1958 revealed a well-balanced $S^{0/00}$ situation. The salinity in the German Bight during the summer of 1954, and almost during the entire year 1959 was, however, abnormally high.

These quarterly deviations from long-term means may also be of importance in connexion with fishery problems in the southern North Sea, especially in the German Bight.

The year 1959, for example, revealed exceptional weather conditions. A long period of drought began

Table 7. Mean values of surface salinity at fixed positions on the Hamburg—Hull route

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Year	Position I; 54°09'N, 07°32'E											
1957	33.43	33.04	32.80	32.25	31.43	31.23	31.88	32.63	32.58	32.33	33.21	33.60
1958	33.20	33.43	31.81	(32.12)	33.31	32.03	32.54	32.63	33.19	33.43	33.52	33.63
1959	32.85	33.33	33.53	33.62	32.97	32.51	32.63	32.66	32.47	33.25	33.92	34.47
	Position II; 54°18'N, 06°12'E											
1957	34.09	34.36	34.51	33.31	33.04	32.76	33.87	34.15	34.56	33.31	34.22	34.33
1958	34.36	34.27	34.17	(34.44)	33.91	32.76	33.57	34.29	34.45	34.52	34.56	34.45
1959	33.96	32.82	33.72	33.55	33.57	33.51	33.65	33.66	33.36	33.95	34.67	34.83
	Position III; 54°19'N, 05°21'E											
1957	34.50	34.49	34.54	34.67	34.19	34.09	34.28	34.67	34.53	34.64	34.55	34.52
1958	34.53	34.70	34.25	(34.36)	34.32	34.44	34.31	34.26	34.43	34.38	34.46	34.60
1959	34.51	33.69	34.06	34.20	34.02	33.92	34.32	34.24	34.03	34.31	34.62	34.91
	Position IV; 54°10'N, 04°26'E											
1957	(34.53)	34.38	34.49	34.55	34.52	34.24	34.55	34.69	34.73	34.81	34.86	34.78
1958	34.69	34.77	34.53	(34.60)	34.48	34.50	34.51	34.51	34.38	34.63	34.67	34.49
1959	34.46	34.52	34.44	34.47	34.39	34.19	34.39	34.56	34.53	34.54	34.72	34.89
	Position V; 54°00'N, 03°32'E											
1957	(34.69)	34.48	34.51	34.64	34.64	34.56	34.61	34.75	34.84	34.86	34.84	34.78
1958	34.76	34.74	34.65	(34.94)	34.75	34.73	34.52	34.69	34.44	34.67	34.74	34.62
1959	34.57	34.57	34.49	34.53	34.47	34.52	34.53	34.61	34.69	34.73	34.73	34.72
	Position VI; 53°53'N, 02°43'E											
1957	(34.66)	34.65	34.65	34.73	34.71	34.70	34.70	34.85	34.73	34.84	34.71	34.71
1958	34.85	34.80	34.66	(34.89)	34.85	34.74	34.80	34.67	34.61	34.63	34.69	34.58
1959	34.64	34.61	34.60	34.65	34.62	34.54	34.59	34.61	34.79	34.75	34.85	34.68
	Position VII; 53°45'N, 01°54'E											
1957	—	34.66	34.68	34.78	34.80	34.84	34.80	34.85	34.66	34.89	34.68	34.77
1958	34.78	34.80	34.76	(34.76)	34.82	34.78	34.76	34.49	34.49	34.53	34.58	34.61
1959	34.65	34.78	34.70	34.70	34.71	34.73	34.59	34.55	34.68	34.72	34.72	34.72

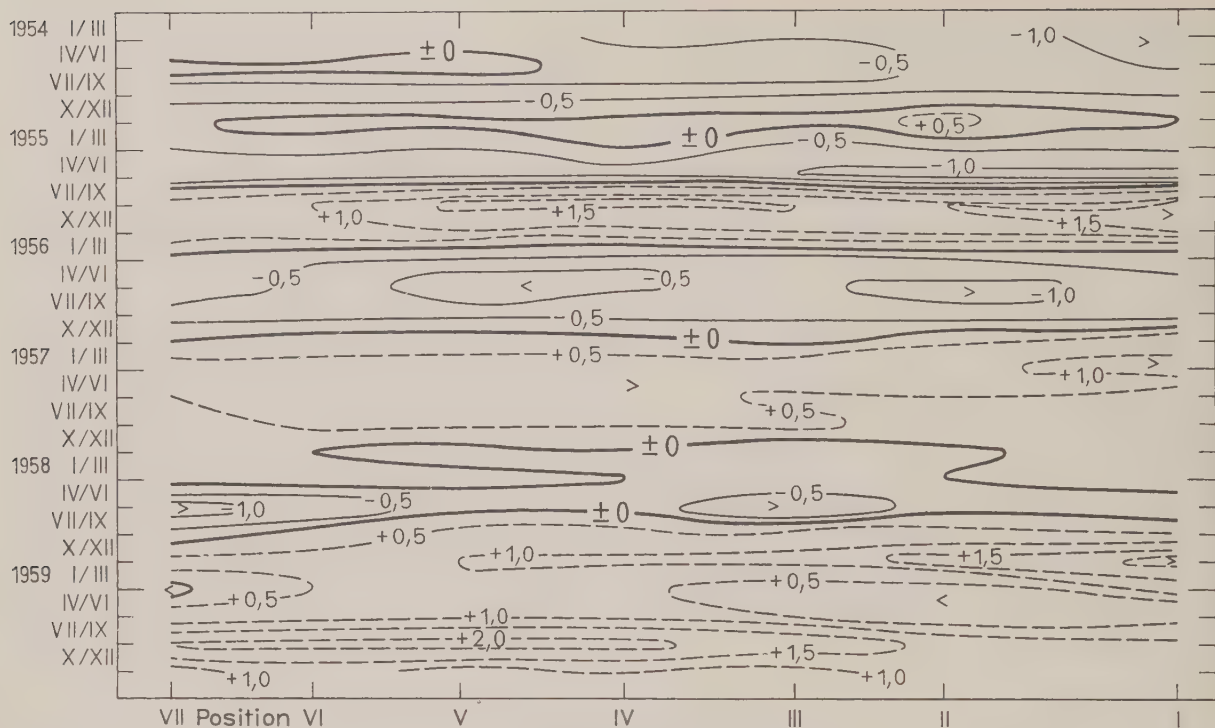


Figure 51. Surface isopleths of the quarterly temperature anomalies in 1954/59 (referred to 1902/28) at the fixed stations on the Hamburg—Hull route.

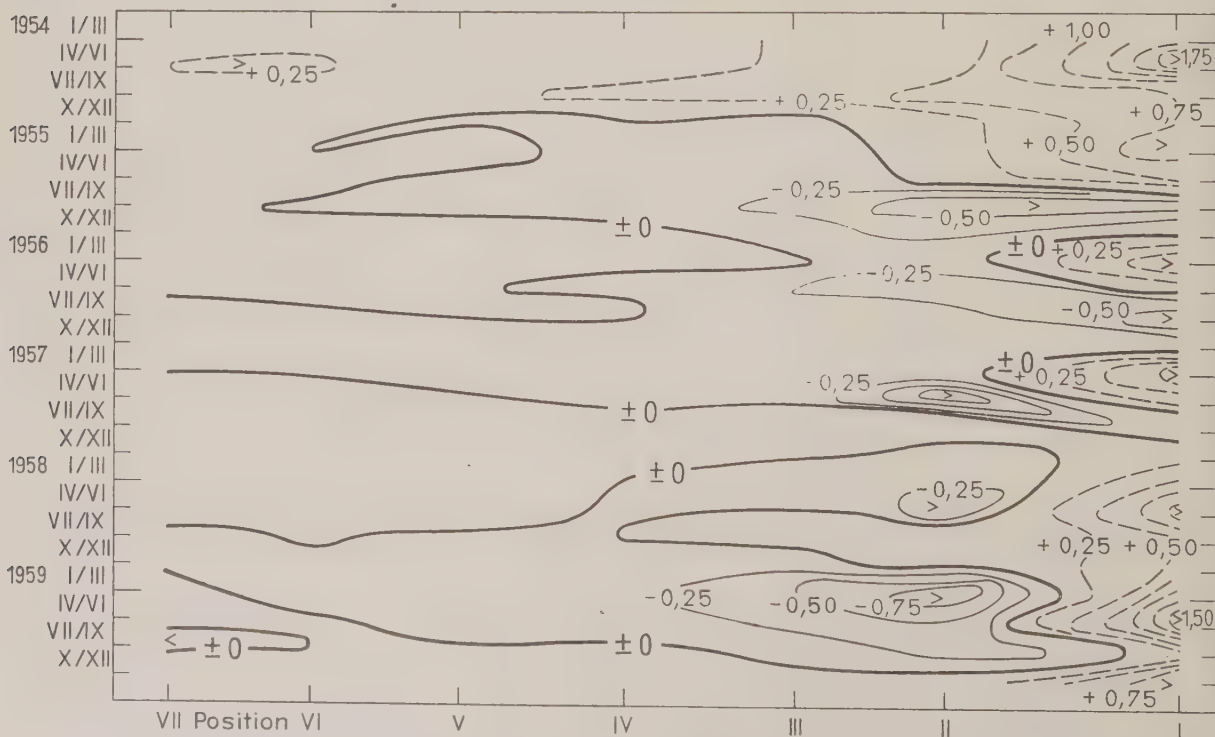


Figure 52. Surface isopleths of the quarterly salinity anomalies in 1954/59 (referred to 1902/28) at the fixed stations on the Hamburg—Hull route.

Table 8; Monthly anomalies of surface temperature for 1953—1959 (referred to 1902 —1928) on fixed positions on the Hamburg—Hull route

Position	Year/Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
I	1953	—	—	—	—	—	—	—	—	+0.9	+1.3	+2.9	(+3.1)
	1954	—	—0.6	—1.6	—1.5	—1.8	±0.0	—1.3	—0.5	—0.1	+0.8	(+2.5)	(—3.2)
	1955	—	—0.1	—1.4	—1.3	—1.3	—0.5	+1.2	+1.8	+2.0	+0.9	+1.5	+2.1
	1956	+1.7	—0.7	—1.9	—1.5	+0.2	—0.5	—0.9	—1.1	—0.6	+0.7	+0.7	+0.6
	1957	+1.1	+1.2	+1.3	+1.0	—0.7	+0.1	+1.1	+0.1	—0.6	+0.1	+0.2	+0.6
	1958	+0.9	+1.1	—0.9	(+1.3)	—1.7	—0.4	—0.5	±0.0	+1.8	+2.6	+2.1	+1.5
	1959	+1.7	+1.0	+0.7	+1.1	—0.3	—0.2	+0.8	+1.5	+1.3	+1.2	+0.5	+1.3
II	1953	—	—	—	—	—	—	—	—	+0.7	+1.4	+2.3	+2.6
	1954	—	—1.1	—0.6	—0.8	—1.0	—0.1	—0.8	—0.8	+0.1	+0.3	+0.9	—
	1955	+0.6	±0.0	—1.9	—1.5	—1.9	—0.7	+1.0	+1.9	+1.5	+1.3	+1.3	+1.4
	1956	+1.1	—1.0	—1.4	—1.7	(—1.6)	—0.8	—0.7	—1.2	—0.5	+0.4	+0.3	+0.5
	1957	+0.2	+1.3	+1.2	+1.4	±0.0	+0.5	+0.6	+0.9	—0.5	+0.2	—0.5	+0.1
	1958	+0.2	—0.1	—0.1	(—1.4)	—0.9	+1.4	+0.3	+0.2	+1.4	+2.0	+1.8	+1.4
	1959	+0.1	—0.1	+0.2	+0.8	—0.1	—0.1	+0.9	+1.9	+1.3	+1.4	+0.7	+1.1
III	1953	—	—	—	—	—	—	—	—	+1.0	+1.4	+2.0	+1.9
	1954	—	—0.3	—0.6	—0.7	±0.0	+0.3	—1.1	—0.6	—0.5	+0.3	+0.0	—
	1955	+0.4	—0.9	—1.2	—1.5	—1.7	+0.1	+1.0	+2.0	+1.6	+0.9	+0.8	+1.6
	1956	+0.6	—1.3	—1.6	—1.0	(—0.9)	—0.6	—0.3	—1.1	—0.8	+0.2	+0.3	(—0.7)
	1957	+0.5	+1.1	+1.3	+1.2	—0.6	+0.7	+0.8	+1.0	±0.0	+0.1	—0.7	—0.5
	1958	+0.2	—0.1	—0.4	(—1.4)	—1.7	+0.2	+0.3	+0.2	+1.5	+1.2	+1.4	+0.9
	1959	±0.0	+0.1	+0.4	+0.3	+1.0	+0.1	+1.5	+2.0	+1.9	+1.3	+0.1	+1.2
IV	1953	—	—	—	—	—	—	—	—	+1.0	+1.3	+1.7	(+3.1)
	1954	—	—0.8	—0.4	—0.9	—0.3	+0.3	—0.9	—0.9	—0.4	+0.1	+0.1	(+0.2)
	1955	+0.4	±0.0	—0.4	—0.8	—1.4	+0.4	+1.2	+2.1	+1.8	+0.3	+0.9	+1.3
	1956	(—0.1)	—0.7	—1.1	—0.9	(±0.0)	—0.3	—0.2	—1.8	—0.4	±0.0	+0.6	±0.0
	1957	(+0.2)	+0.8	+1.0	+1.0	—0.3	+1.3	+1.0	+0.8	+0.1	+0.5	—0.3	—0.1
	1958	+0.4	+0.3	—0.6	(+0.4)	—1.2	—0.1	+0.2	+0.2	+1.6	+0.8	+1.4	+1.5
	1959	+1.3	+0.4	+0.2	+0.7	+0.7	+1.0	+2.0	+2.2	+2.1	+1.6	+0.3	+1.1
V	1953	—	—	—	—	—	—	—	—	—	—	+1.4	(+2.7)
	1954	—	—0.2	—0.1	—	—	+0.3	—1.1	—0.7	—0.6	—0.2	+0.2	(—0.1)
	1955	±0.0	—0.2	—1.2	—0.2	—1.5	±0.0	+1.5	+2.2	+1.4	+0.4	+1.0	+1.6
	1956	+0.5	—1.5	—0.9	—0.6	(—0.4)	+0.2	±0.0	—1.4	—0.3	+0.1	+0.4	+0.4
	1957	(+0.2)	+0.9	+1.0	+1.0	—0.5	+1.1	+0.9	+0.6	—0.1	—0.1	—0.3	+0.2
	1958	+0.3	+0.1	+0.1	(+0.5)	—1.2	+0.1	+0.7	+0.1	+1.3	+1.0	+1.0	+0.9
	1959	+0.8	+0.5	+0.9	+0.5	+0.7	+1.6	+2.2	+2.5	+2.6	+1.6	+0.2	+0.7
VI	1953	—	—	—	—	—	—	—	—	+0.4	+1.3	+2.0	(+2.9)
	1954	—	—0.8	—0.1	+0.2	—0.1	—0.2	—0.9	—1.0	—0.9	±0.0	+0.4	+0.3
	1955	+0.7	—0.4	—1.5	—0.5	—1.1	—0.6	+0.7	+1.3	+1.1	—0.7	+1.6	+1.9
	1956	+0.5	—1.2	—0.7	—1.0	(—0.6)	—0.4	+0.2	—1.7	—0.6	—0.3	+0.6	+0.5
	1957	(+0.1)	+0.9	+0.9	+0.8	—0.2	+1.1	+1.1	+0.7	±0.0	—0.3	±0.0	+0.3
	1958	+0.7	—0.2	+0.4	—0.9	—1.4	—0.4	+0.5	—0.5	+0.4	—0.1	+1.0	+1.3
	1959	+0.7	+0.2	+0.6	+1.0	+0.8	+1.6	+1.3	+1.9	+2.7	+2.3	+0.5	+1.2
VII	1953	—	—	—	—	—	—	—	—	+0.5	+1.1	+1.4	(+1.9)
	1954	—	—0.8	—0.1	+0.1	+0.5	—0.1	—0.9	—1.0	—0.7	—0.3	+0.1	—
	1955	(+0.5)	—0.4	—1.7	—0.9	—1.2	±0.0	—0.1	+1.0	+1.0	—0.3	+1.1	(+1.8)
	1956	+0.9	—0.9	—0.3	—0.5	(+0.8)	—0.3	+0.2	—1.5	—0.7	—0.7	+0.4	+0.2
	1957	(+0.1)	+1.0	+1.0	+0.6	+0.1	+0.7	+0.9	+0.4	—0.5	+0.3	—0.3	+0.5
	1958	+0.5	±0.0	—0.2	(—1.0)	—1.1	—1.2	—0.3	—0.9	—0.1	+0.2	+0.9	+1.4
	1959	—1.2	+0.8	+0.2	+0.5	+0.7	+1.4	+1.8	+1.4	+2.9	+1.7	—0.1	+0.9

Table 9; Monthly anomalies of surface salinity for 1953—1959 (referred to 1902—1928) on fixed positions on the Hamburg—Hull route

Position	Year/Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
I	1953	—	—	—	—	—	—	—	—	—0.64	—0.10	+0.17	(+0.71)
	1954	—	+1.38	+1.68	+1.70	+1.48	+2.74	+1.20	+0.72	+0.42	+1.59	(+0.90)	(—0.23)
	1955	—	+0.75	+1.22	+0.86	—0.07	+0.93	—1.37	—0.60	+0.12	+0.71	—0.39	—0.44
	1956	+0.71	+0.64	+0.85	+0.84	—1.20	+0.69	—1.57	—0.72	+0.45	+0.22	—0.15	—0.32
	1957	+1.43	+0.44	+0.80	+1.25	—0.77	+0.23	—0.52	+0.13	+0.08	—0.27	+0.11	+0.60
	1958	+1.20	+0.83	—0.19	(+1.12)	+1.11	+1.03	+0.14	+0.13	+0.69	+0.83	+0.42	+0.63
	1959	+0.85	+0.73	+1.53	+2.62	+0.77	+1.51	+0.23	+0.16	—0.03	+0.65	+0.82	+1.47
II	1953	—	—	—	—	—	—	—	—	+0.16	—0.09	+0.30	+0.25
	1954	—	+0.16	+0.33	+0.34	+0.38	+0.45	+0.91	+0.41	+0.48	+0.04	+0.25	—
	1955	+0.43	+0.09	—0.07	+0.16	+0.14	+0.01	—0.82	—0.97	—0.12	—0.76	—0.16	—0.34
	1956	—0.07	—0.09	—0.26	—0.17	(—0.25)	—0.69	—0.56	—0.10	+0.18	—0.09	+0.03	—0.08
	1957	—0.41	—0.14	+0.11	—0.89	—0.96	—1.14	—0.03	+0.15	+0.51	—0.09	—0.18	—0.17
	1958	—0.14	—0.23	—0.23	(+0.24)	—0.09	—1.14	—0.33	+0.29	+0.40	+0.12	+0.16	—0.05
	1959	—0.54	—1.68	—0.68	—0.65	—0.43	—0.39	—0.25	—0.34	—0.69	—0.45	+0.27	+0.33
III	1953	—	—	—	—	—	—	—	—	+0.03	—0.09	+0.20	+0.12
	1954	—	+0.29	+0.26	+0.20	+0.25	+0.35	+0.56	+0.33	+0.16	—0.20	+0.06	—
	1955	+0.10	+0.04	—0.33	—0.05	+0.07	—0.62	—0.29	—0.64	—0.10	—0.46	+0.12	±0.00
	1956	+0.06	+0.18	—0.19	—0.40	(+0.03)	—0.41	—0.58	+0.10	+0.14	—0.12	—0.05	(—0.01)
	1957	—0.15	—0.11	—0.01	+0.17	—0.11	—0.21	+0.08	+0.37	+0.18	+0.09	±0.00	—0.03
	1958	—0.12	+0.10	—0.30	(—0.14)	+0.02	+0.14	+0.11	—0.04	+0.08	—0.17	—0.09	+0.05
	1959	—0.14	—0.91	—0.49	—0.30	—0.28	—0.38	+0.12	—0.06	—0.32	—0.24	+0.07	+0.36
IV	1953	—	—	—	—	—	—	—	—	+0.08	+0.07	+0.06	(+0.04)
	1954	—	+0.07	+0.18	+0.13	+0.14	+0.12	+0.38	+0.35	+0.20	+0.05	—0.03	(—0.03)
	1955	—0.08	+0.05	—0.16	—0.03	—0.01	—0.23	—0.14	—0.11	—0.07	—0.25	+0.26	+0.10
	1956	(+0.10)	+0.18	+0.13	—0.15	(—0.14)	—0.10	+0.01	+0.18	+0.06	—0.05	—0.02	—0.12
	1957	—0.17	—0.27	—0.16	—0.05	—0.03	—0.31	+0.15	+0.29	+0.18	+0.16	+0.21	+0.08
	1958	—0.01	+0.12	—0.12	(±0.00)	—0.07	—0.05	+0.11	+0.11	—0.17	—0.02	+0.02	—0.21
	1959	—0.24	—0.13	—0.21	—0.13	—0.16	—0.36	—0.01	+0.16	—0.02	—0.11	+0.07	+0.19
V	1953	—	—	—	—	—	—	—	—	—	—	+0.15	(+0.07)
	1954	—	+0.13	+0.18	—	—	+0.17	+0.28	+0.22	+0.01	—0.06	+0.08	(—0.06)
	1955	+0.10	+0.14	—0.03	—0.11	+0.14	—0.07	—0.20	—0.18	—0.05	+0.15	+0.25	+0.27
	1956	+0.16	+0.08	+0.06	—0.01	(+0.11)	+0.01	—0.01	+0.09	—0.04	—0.10	+0.04	—0.05
	1957	(+0.04)	—0.22	—0.19	—0.06	+0.14	+0.01	+0.06	+0.20	+0.14	+0.16	+0.19	+0.08
	1958	+0.11	+0.04	—0.05	(+0.24)	+0.25	+0.18	—0.03	+0.14	—0.26	—0.03	+0.09	—0.08
	1959	—0.08	—0.13	—0.21	—0.17	—0.03	—0.03	—0.02	+0.06	—0.01	+0.03	+0.08	+0.02
VI	1953	—	—	—	—	—	—	—	—	+0.07	+0.13	+0.12	(+0.12)
	1954	—	+0.19	+0.16	+0.07	+0.40	+0.35	+0.20	+0.12	—0.05	+0.06	+0.05	(+0.02)
	1955	+0.09	+0.13	—0.21	—0.06	+0.28	+0.23	—0.10	—0.11	+0.07	+0.19	+0.23	+0.14
	1956	+0.14	+0.06	±0.00	—0.02	(+0.19)	+0.15	+0.01	—0.06	—0.10	—0.06	—0.01	—0.08
	1957	(+0.01)	—0.05	—0.10	—0.02	+0.21	+0.20	+0.05	+0.20	+0.03	+0.19	+0.06	+0.01
	1958	+0.20	+0.10	—0.09	(+0.14)	+0.35	+0.24	+0.15	+0.02	—0.09	—0.02	+0.04	—0.12
	1959	—0.01	—0.09	—0.15	—0.10	+0.12	+0.04	—0.06	—0.04	+0.09	+0.10	+0.20	—0.02
VII	1953	—	—	—	—	—	—	—	—	+0.14	+0.21	+0.15	(+0.09)
	1954	—	+0.11	+0.13	+0.20	+0.35	+0.23	+0.13	+0.04	—0.09	+0.06	+0.06	—
	1955	(+0.19)	+0.25	—0.13	—0.02	+0.05	+0.05	+0.09	+0.09	+0.08	+0.23	+0.14	(+0.04)
	1956	+0.08	+0.06	—0.02	+0.04	(+0.12)	+0.05	+0.02	—0.07	—0.16	—0.10	+0.03	—0.14
	1957	—	+0.01	—0.07	+0.03	+0.15	+0.19	+0.15	+0.25	+0.01	+0.29	+0.08	+0.12
	1958	+0.18	+0.15	+0.01	(+0.01)	+0.17	+0.13	+0.11	—0.11	—0.16	—0.07	—0.02	—0.04
	1959	+0.05	+0.13	—0.05	—0.05	+0.06	+0.08	—0.06	—0.05	+0.03	+0.12	+0.12	+0.07

in February and ended only in the second half of December. February excepted, every month of that year was warmer than normal. The high air temperatures during the entire summer increased the effect of the drought¹⁾. This is the reason

why the surface temperatures in the whole southern North Sea were abnormally high in the year 1959, and especially during the last quarters of the year, and why the surface salinity in the German Bight had a positive anomaly, the run-off of the rivers Elbe and Weser showing negative anomalies.

¹⁾ Deutscher Wetterdienst: (a) Monatliche Witterungsberichte, 7. Jahrg.; (b) Die Großwetterlagen Mitteleuropas, 12. Jg. Offenbach 1959.

Hydrographic Conditions in the German Bight in 1959

(Figure 53; Tables 10–11)

Daily surface observations of temperature and salinity at 8^h MET have been continued in 1959 from 5 German lightships, viz. "Borkumriff", "P8", "P12", Elbe 1" and "Weser". This conforms with the routine commenced in 1949, with exception of the "Borkumriff", where observations were initiated in 1954. (For positions, see Ann. Biol., 14, p. 60.) The data collected will be published in full in "Meereskundliche Beobachtungen und Ergebnisse". The monthly means of the surface observations, presented in Table 10, together with the means for the period of ten years 1950/59

give a good impression of the hydrographical conditions in the estuaries and coastal waters of the German Bight. The mean values of bottom observations carried out by the "Borkumriff", from which subsurface observations at various depths were made once a week, are also presented in Table 10. It should be noted that the monthly means of "P12" for the period May to September have been computed from observations which German commercial vessels made on the Hamburg-Hull route.

In comparison with the ten-year means, surface temperatures were comparatively high almost throughout the year 1959, but especially in the summer. The 1959 surface salinities were rather high in the German Bight in the period March to

Table 10. Monthly means of temperature and salinity at surface and bottom, for 1950/59 and 1959 at the German lightvessels "Borkumriff", "P 8", "P 12", "Elbe 1", and "Weser"
(From Deutsches Hydrographisches Institut, Hamburg)

Month		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Temperature		Surface											
"Borkumriff"	1959	5.4	3.9	4.5	7.1	10.4	13.9	17.5	19.2	18.1	15.0	10.5	6.1
	1959	5.6	4.1	4.6	7.0	10.4	14.3	17.4	18.9	18.0	15.0	10.5	6.4
		Bottom											
"P 8"	Mean 1950/59	5.4	3.7	3.4	5.1	8.8	12.8	15.7	16.9	16.4	14.0	10.9	7.7
	1959	5.9	4.3	4.3	6.0	8.9	13.3	16.8	18.4	17.2	14.8	11.4	7.5
		Surface											
"P 12"	Mean 1950/59	4.7	3.0	3.2	5.5	9.4	13.1	16.0	17.1	16.1	13.4	10.4	7.2
	1959	4.5	3.0	3.9	6.3	(9.4)	(14.3)	(17.0)	(18.3)	(17.4)	14.7	10.4	6.9
		Surface											
"Elbe 1"	Mean 1950/59	3.9	2.5	3.0	5.6	9.3	12.9	16.1	17.2	16.2	13.1	9.8	6.5
	1959	4.2	2.9	3.8	6.6	10.4	13.9	17.2	18.7	17.6	14.1	9.7	6.6
		Surface											
"Weser"	Mean 1950/59	3.8	2.6	3.0	5.4	8.8	12.7	15.9	17.2	16.1	13.1	9.8	6.4
	1959	4.0	3.0	3.9	6.6	9.8	13.7	17.0	18.4	17.4	14.0	9.8	6.3
Salinity		Surface											
"Borkumriff"	1959	31.46	31.79	32.23	32.28	32.22	32.48	32.76	32.91	32.97	33.34	33.54	32.66
	1959	31.90	32.10	32.46	32.34	32.35	32.49	32.77	32.97	33.00	33.30	33.64	32.84
		Bottom											
"P 8"	Mean 1950/59	33.63	33.59	33.32	33.26	32.79	32.63	32.83	32.86	33.02	33.44	33.72	33.65
	1959	33.36	33.48	33.48	33.43	33.16	32.57	32.84	32.71	32.65	33.11	33.97	34.10
		Surface											
"P 12"	Mean 1950/59	32.39	32.19	32.15	31.32	31.40	31.43	31.85	31.90	31.72	32.15	32.64	32.75
	1959	31.73	30.98	32.55	32.28	(32.02)	(31.91)	(32.25)	(31.83)	(31.51)	32.64	33.00	34.00
		Surface											
"Elbe 1"	Mean 1950/59	31.24	31.08	30.85	30.53	30.74	31.16	31.21	31.41	31.16	31.21	31.72	31.74
	1959	30.44	30.48	31.40	31.69	30.90	31.16	31.51	31.40	31.18	31.86	32.52	33.60
		Surface											
"Weser"	Mean 1950/59	31.60	31.72	31.96	31.95	32.13	32.13	32.16	32.05	31.86	31.87	32.21	32.28
	1959	30.93	31.47	32.18	32.03	32.51	32.24	32.30	32.61	32.16	32.29	32.78	33.78

Table 11. Annual mean of surface temperature and salinity in 1959

Lightvessel	"Borkumriff"		"P 8"		"P 12"		"Elbe 1"		"Weser"	
	t°C	S ‰	t°C	S ‰	t°C	S ‰	t°C	S ‰	t°C	S ‰
Mean 1950/59	—	—	10.1	33.22	9.9	31.94	9.7	31.15	9.6	31.98
Mean 1959	11.0	31.72	10.7	33.24	(10.5)	(32.22)	10.5	31.51	10.3	32.27

May, and again in the period October/December, as compared with the ten-year means.

Table 11 shows that the annual means of temperature and salinity are comparatively high referred to the period 1950/59.

These positive anomalies of t°C and S‰ may be of some importance for biological problems.

The high temperatures and continuous drought make the summer of 1959 one of the most remarkable of the last 70 years recorded in northern Germany. The reason is to be found in the general weather situation. Northern and western Europe were at that time under the influence of the subtropical high pressure areas¹⁾. It is very interesting that the zone of the greatest deficit in

precipitation is identical with the region of the greatest surplus of heat, along the axis Paris—Norderney—Stockholm. These zones are identical with the area of increased atmospheric pressure, too. The anticyclones of the Azores advanced far to the north in that season.²⁾

Therefore it is of interest to know the short-range variations of temperature and salinity at the surface in the German Bight. In Figure 53 the temperature deviations from the long-term mean are presented per decade, together with the

1) Deutsche Gewässerkdl. Mitt., 4 (1): 3—7. Koblenz, 1960.

2) Deutscher Wetterdienst: Beilage z. Wetterk., No. 37. Offenbach, 1959.

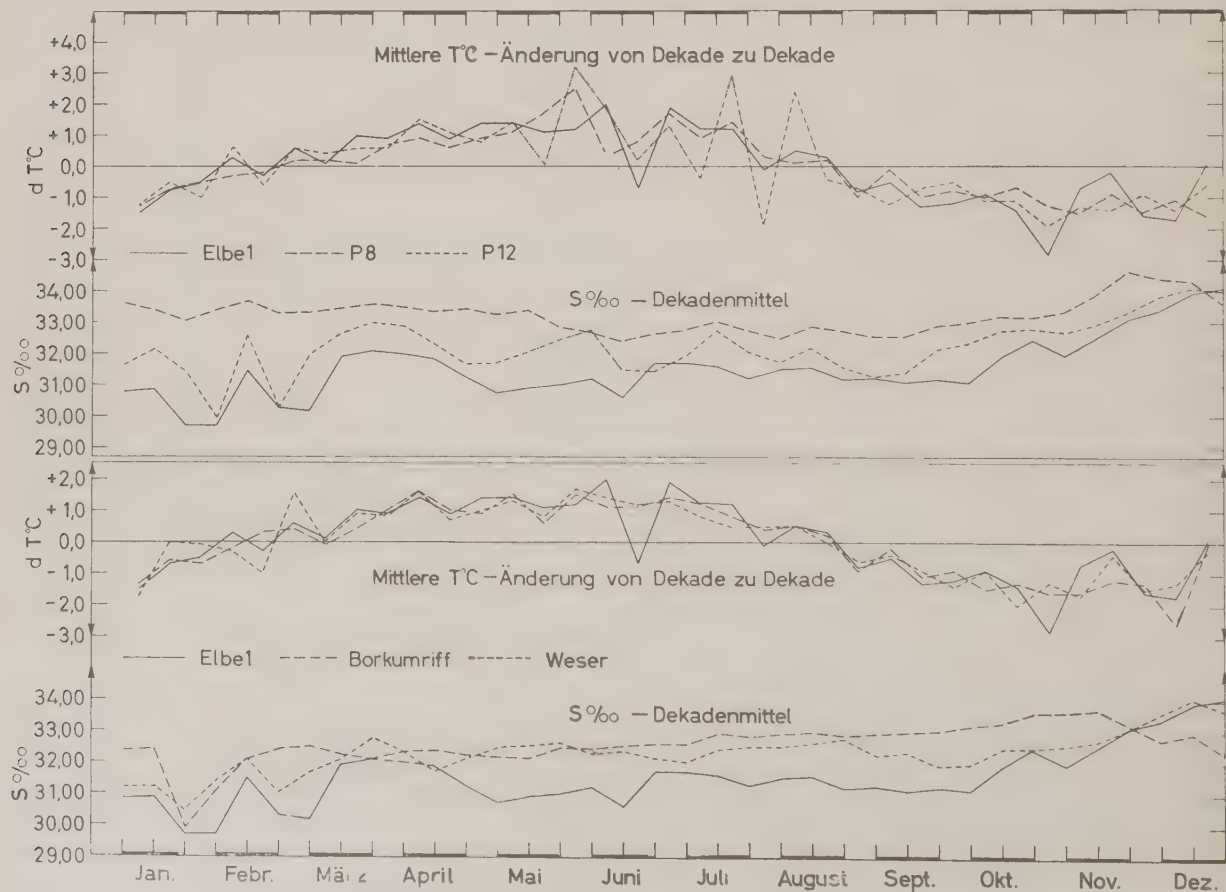


Figure 53. Mean temperature variation from decade to decade (ten-day means) and mean salinity decades (ten-day means) at the German lightvessels of the German Bight in 1959.

salinity means per decade. Surface temperatures reveal greater fluctuations in spring and autumn than in the other seasons. The surface salinity shows an increased inflow of high salinity water into the German Bight from March to May, and above all from October to December.

E. GOEDECKE

Monthly Anomalies of the Surface Temperature in an Area off the Eastern Coast of Scotland in 1959

(Figure 54; Table 12)

Table 12 gives for each month of 1959 the anomaly of the surface temperature in the area F (56°N—60°N, 0°—3°W; see Figure 54). As standards were used the grand monthly means for 1°-squares over the period 1876—1915.

Table 12. Monthly anomalies ($\Delta^{\circ}\text{C}$) and number (n) of observations of the surface temperature in the North Sea area F in 1959

Jan.	Feb.	March	April	May	June	July
Δ n	Δ n	Δ n	Δ n	Δ n	Δ n	Δ n
0.3 39	0.6 38	0.8 40	1.2 35	1.3 40	0.9 46	0.8 61
Aug.	Sept.	Oct.	Nov.	Dec.	Average	
Δ n	Δ n	Δ n	Δ n	Δ n	of Δ -values	
1.2 59	1.7 48	2.0 40	1.4 32	1.3 29	1.1	

It appears from Table 12 that the anomaly is positive for each month of 1959. Averaged over the year the anomaly is 1.1° C, as compared with 0.5° C only in 1958. In this connexion it might be menti-

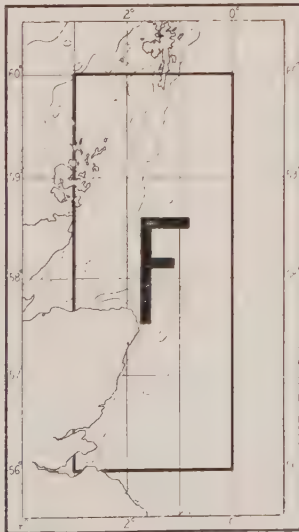


Figure 54. Location of area.

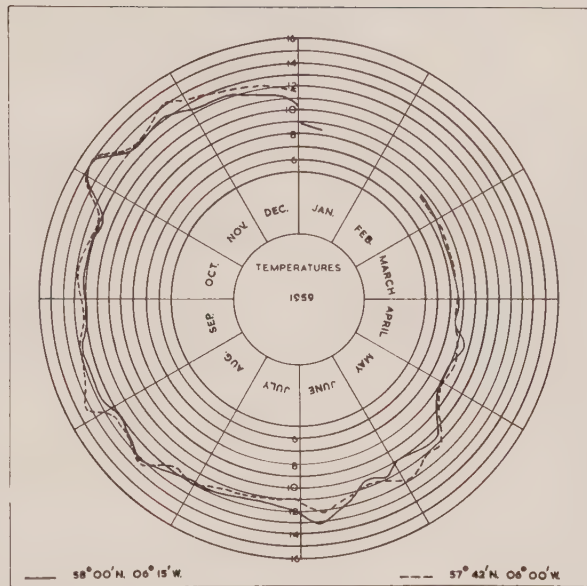


Figure 55. Sea temperature at 3 m depth at two selected positions in the North Minch. Compiled from weekly observations.

oned that also in the neighbouring areas of the Atlantic — to the north-west of the area here considered — a rise of temperature from 1958 to 1959 has taken place (see page 23).

JENS SMED

Upper Water Temperature in the North Minch 1959

(Figure 55)

In Figure 55 is shown the variation of sea temperature at 3 m depth at two stations. These data are from a thermograph on R.M.S. "Loch Seaforth" and the Department of Agriculture and Fisheries for Scotland is indebted to Messrs. David MACBRAYNE and Captain SMITH for the records.

The temperature was about the usual in the spring and summer of 1959, but in September to December was very much higher than has been recorded previously in this rather short set of records. The values for November lie about 3° centigrade above the usual value. In this respect 1959 shows a similarity to 1958, but was even more extreme.

R. E. CRAIG

Hydrography of the Kattegat Area Danish Waters

(Tables 13-14)

At the lightvessel "Anholt Nord" the surface temperature was above normal throughout the year, and unusually high in spring and autumn. Except for July and August the bottom temperatures were also above normal and unusually high in winter.

The surface salinity was very high in September. At the bottom, salinities above normal prevailed with marked deviations in January/February and August/December.

HELGE THOMSEN

Swedish Waters

(Tables 15-16)

The salinities of the deeper water layers were especially high towards the end of the year 1959. A mean value as high as 34.8‰ at 40 m depth at "Vinga" in December is a rare occurrence, indeed. During the entire period 1947-1959 the three highest values of mean salinity recorded were: 35.0, 34.9, and 34.8‰. Values of 35.28‰ were measured here for many days in succession in December 1959. In the same month a salinity as high as 35.34‰ was found in the deeper part of the Skagerak, viz. at 200 m depth (see Table 16). Surface temperatures have been above normal throughout the year, with one exception only.

ARTUR SVANSSON

Table 13. Monthly means of salinity and temperature at surface and bottom at the lightvessel "Vyl" for a longer series of years, and deviations from these means

(From the Danish Meteorological Institute, Nautical Department)

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Salinity	Surface											
Mean	32.6	32.4	32.2	32.4	32.3	32.6	32.5	32.4	32.6	32.4	32.4	32.9
Deviation 1959	0.2	0.0	-0.3	-0.4	0.5	0.5	0.4	0.6	0.8	0.8	0.8	1.2
	Bottom											
Mean (20 m)	32.9	32.7	32.7	32.7	32.6	33.0	32.8	32.6	32.7	32.6	32.6	33.0
Deviation 1959	0.5	0.2	-0.4	0.0	0.6	0.4	0.3	0.5	0.9	0.7	0.8	1.2
Temperature	Surface											
Mean	3.2	2.2	2.6	4.8	8.8	12.4	15.2	16.1	15.0	12.2	8.5	5.4
Deviation 1959	2.2	1.1	1.3	1.4	1.3	0.4	1.2	2.0	1.2	1.8	2.0	2.0
	Bottom											
Mean (20 m)	3.8	2.6	3.0	4.8	8.0	11.1	14.1	16.0	15.1	12.7	9.1	6.2
Deviation 1959	2.0	1.3	0.9	1.0	1.2	1.3	1.5	1.4	0.9	1.4	1.4	1.1

Table 14. Monthly means of salinity and temperature at surface and bottom at the lightvessel "Anholt Nord" for a longer series of years, and deviations from these means

(From the Danish Meteorological Institute, Nautical Department)

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Salinity	Surface											
Mean	23.5	23.1	20.2	19.2	18.1	18.9	19.4	20.1	20.7	20.7	21.9	22.8
Deviation 1959	0.3	-1.2	-0.9	-1.5	-1.5	1.1	0.6	-0.1	3.2	1.8	0.2	-0.2
	Bottom (30 m)											
Mean (28 m)	31.8	32.0	32.5	33.0	33.1	32.8	32.3	31.9	31.8	32.2	32.4	32.1
Deviation 1959	1.9	1.3	-0.4	0.1	0.7	0.6	0.8	1.1	1.2	1.0	1.1	1.9
Temperature	Surface											
Mean	2.2	1.4	1.9	4.5	9.4	14.2	16.8	16.7	14.5	10.9	7.1	4.1
Deviation 1959	0.7	0.0	1.2	1.3	1.7	0.9	1.8	2.4	1.4	2.0	1.7	0.9
	Bottom (30 m)											
Mean (28 m)	6.1	4.7	4.3	4.3	4.9	6.7	9.7	12.7	13.1	12.1	10.2	8.1
Deviation 1959	1.9	1.8	0.6	0.8	0.4	0.0	-0.3	-1.3	0.3	0.7	1.6	0.7

Table 15. Monthly means of salinity and temperature in 1959 at surface and bottom for the Swedish lightships "Vinga" and "Svinbådan", and deviations from the 1950—1958 means

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Salinity	Surface											
"Vinga"	25.5	24.3	20.9	19.0	17.7	23.1	21.7	23.0	28.5	25.0	24.6	23.4
Deviation	+0.9	+0.8	-1.5	-2.9	-3.5	+2.6	-0.1	+0.9	+5.0	+0.2	+0.7	-2.4
"Svinbådan"	17.2	13.1	11.1	12.4	11.0	14.2	12.8	14.7	18.6	13.4	13.5	20.1
Deviation	+1.9	-2.4	-3.2	-1.0	-1.5	+1.4	-1.1	+1.5	+3.6	-2.4	-1.6	+3.7
	Bottom											
"Vinga"	33.8	34.0	34.3	34.4	34.5	33.8	33.7	34.0	33.6	33.9	34.4	34.8
Deviation	-0.1	-0.3	+0.1	0.0	+0.1	-0.2	0.0	+0.5	+0.1	+0.4	+0.5	+1.0
"Svinbådan"	26.1	25.6	30.5	31.6	32.8	28.5	27.6	28.6	22.9	28.3	32.0	33.7
Deviation	-2.0	-3.3	+0.4	+0.3	+2.4	-1.5	-0.3	+1.4	-4.2	+0.7	+2.9	+4.9
Temperature	Surface											
"Vinga"	2.6	1.5	3.2	5.7	11.2	14.9	18.9	19.1	15.9	12.6	8.7	4.9
Deviation	+0.2	+0.4	+1.6	+1.3	+1.5	+0.5	+2.0	+2.0	+0.8	+0.9	+0.8	-0.2
"Svinbådan"	2.7	1.3	2.9	5.7	10.7	15.4	18.6	19.2	16.4	12.5	8.5	5.0
Deviation	+0.5	0.0	+1.1	+1.3	+1.4	+1.0	+1.6	+2.3	+1.4	+1.2	+0.8	+0.3
	Bottom											
"Vinga"	6.0	5.3	5.2	5.6	6.0	7.7	8.8	11.0	12.0	12.1	10.6	7.9
Deviation	-0.2	+0.3	+0.2	+0.9	+0.4	+1.0	-0.3	-0.1	-0.9	-0.3	+0.8	-0.1
"Svinbådan"	6.0	3.8	5.3	5.3	5.7	9.4	12.3	12.7	16.1	12.9	11.6	9.4
Deviation	+0.5	-0.8	+0.7	+0.3	0.0	+2.2	+2.1	+0.4	+3.9	+1.3	+1.0	+1.5

Table 16.

		M 6					
		58°10'N		09°30'E			
Depth,		Date					
m		8/1	26/2	9/4	25/7	14/10	17/12
Salinity	0	30.65	27.00	28.67	30.23	33.44	28.97
	10	32.33	—	33.62	32.09	33.42	29.23
	20	34.35	34.54	34.38	34.79	33.78	—
	30	34.90	34.79	34.71	34.90	34.82	32.39
	50	35.20	35.03	34.99	34.99	35.02	32.84
	100	35.20	35.16	35.12	35.11	35.18	34.10
	200	35.21	35.17	35.16	35.15	35.26	35.34
	400	35.21	35.23	35.22	35.21	35.17	35.18
	600	35.25	35.24	35.24	35.21	35.17	35.36
Temperature	0	3.43	1.96	5.22	20.23	12.92	5.33
	10	4.72	—	5.09	13.87	12.91	5.40
	20	7.12	5.99	5.40	7.32	13.52	—
	30	7.69	6.55	6.23	6.65	10.94	7.69
	50	7.76	6.97	6.91	6.42	8.14	7.71
	100	6.78	7.04	6.73	6.48	8.04	9.00
	200	6.31	6.28	6.64	6.39	7.60	8.24
	400	5.59	5.79	5.66	5.67	5.92	6.62
	600	5.39	5.51	5.46	5.46	5.58	5.82

C. Baltic-Belt Seas

Danish Observations in Great Belt and the Baltic

(Tables 17-19)

Throughout the period June—October the temperature at the lightvessels "Halsskov Rev" and

"Gedser Rev" were unusually high. In this period the monthly means of the temperature in 15 m at "Gedser Rev" were the highest recorded for the past 30 years.

HELGE THOMSEN

Table 17. Monthly means of salinity and temperature at surface and bottom at the lightvessel "Halsskov Rev" for a longer series of years, and deviations from these means

(From the Danish Meteorological Institute, Nautical Department)

[illegible]

Table 18. Monthly means of salinity and temperature at surface and bottom at the lightvessel "Gedser Rev" for a longer series of years, and deviations from these means

(From the Danish Meteorological Institute, Nautical Department)

Month	I	II	III	IV	V	VI	VII	IX	X	X	XI	XII
Salinity												
	Surface											
Mean	12.1	11.4	10.2	9.7	8.8	9.1	9.1	9.7	9.8	10.2	11.9	11.9
Deviation 1959	1.1	-1.0	-1.3	-1.1	-0.6	1.0	0.1	-0.5	0.0	0.1	-2.1	-0.8
	Bottom											
Mean (15 m)	13.9	12.7	13.8	13.1	12.9	13.4	12.6	11.9	12.4	12.6	12.2	13.1
Deviation 1959	0.5	-0.2	-1.9	0.1	-0.3	1.4	1.6	3.4	2.8	2.4	0.0	-0.8
Temperature												
	Surface											
Mean	2.2	1.5	2.1	4.1	8.0	12.6	15.8	16.1	14.3	11.1	7.6	4.3
Deviation 1959	0.7	0.3	0.7	1.1	1.0	1.8	1.8	2.6	2.7	2.1	1.2	0.6
	Bottom											
Mean (15 m)	2.8	2.2	2.2	3.6	6.3	10.1	13.1	14.4	14.0	11.8	7.9	4.8
Deviation 1959	0.4	-0.3	0.3	1.0	1.3	3.0	2.8	2.8	3.0	1.9	1.7	0.3

Table 19. Monthly means of salinity and temperature at Christiansø for a longer series of years, and deviations from these means

(From the Danish Meteorological Institute, Nautical Department)

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Salinity												
Mean	7.0	7.0	7.0	7.0	7.0	7.2	7.4	7.2	7.0	7.0	7.1	7.0
Deviation 1959	0.7	0.5	0.6	0.5	0.6	0.5	0.5	0.8	0.7	1.0	0.9	1.0
Temperature												
Mean	3.3	2.1	1.8	3.0	6.1	11.0	15.2	16.0	14.1	11.1	8.1	5.5
Deviation 1959	0.1	0.1	0.9	0.8	1.3	1.6	2.1	3.0	2.5	2.3	1.4	0.8

Table 20. Monthly means of temperature and salinity at surface and bottom, for the period 1950/59 and 1959, at the German lightvessels "Flensburg", "Kiel" and "Fehmarnbelt"
(From Deutsches Hydrographisches Institut, Hamburg)

Month		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Temperature													
"Flensburg"	Mean 1950/59	2.8	1.2	1.6	4.6	9.5	14.0	16.4	16.8	15.1	12.0	8.1	5.2
	1959	3.7	1.8	2.9	6.4	11.4	14.7	18.3	19.9	17.1	13.0	8.8	4.6
		Surface											
"Kiel"	Mean 1950/59	2.6	1.2	1.7	4.8	9.4	14.0	16.9	17.2	15.4	12.0	8.4	5.1
	1959	2.9	1.5	2.7	6.1	10.2	14.8	18.2	19.6	17.1	12.9	8.5	4.7
		Surface											
"Fehmarnbelt"	Mean 1950/59	2.8	1.3	1.8	4.8	9.1	13.7	16.8	17.2	15.4	12.1	8.4	5.2
	1959	3.2	1.8	3.0	6.1	10.0	15.1	18.6	19.6	17.1	13.0	8.7	4.8
		Bottom											
	Mean 1950/59	3.6	2.3	2.4	3.8	5.3	6.9	8.4	10.3	12.2	12.1	9.6	6.0
	1959	4.4	2.5	2.9	4.8	5.6	7.6	9.3	11.4	12.9	13.6	10.4	5.9
Salinity													
"Flensburg"	Mean 1950/59	19.46	18.20	16.72	16.14	14.92	14.85	15.85	16.58	17.43	18.46	18.52	19.14
	1959	19.25	17.93	17.19	15.31	13.42	14.69	16.09	15.05	16.30	16.82	18.47	17.60
		Surface											
"Kiel"	Mean 1950/59	18.81	17.61	16.36	15.29	13.91	13.53	14.17	14.89	15.53	17.83	18.06	18.69
	1959	18.28	17.35	16.44	15.20	12.55	13.87	15.21	13.06	13.78	17.86	17.67	17.42
		Surface											
"Fehmarnbelt"	Mean 1950/59	15.24	13.15	12.39	12.42	10.97	11.41	12.32	12.08	14.13	15.12	14.01	15.88
	1959	17.18	12.21	11.72	11.15	9.39	13.44	12.35	11.94	13.80	13.15	13.74	14.04
		Bottom											
	Mean 1950/59	19.70	20.24	20.07	23.98	26.30	27.68	28.13	26.61	24.82	22.12	20.36	20.36
	1959	20.51	19.00	19.68	25.08	26.87	28.23	27.22	27.05	24.50	21.22	20.47	19.08

Table 21. Annual mean of surface temperature and salinity in 1959

Lightvessel	"Flensburg"		"Kiel"		"Fehmarnbelt"	
	t°C	S ‰	t°C	S ‰	t°C	S ‰
Mean 1950/59	8.9	17.19	9.1	16.18	9.1	13.26
1959	10.2	16.51	9.9	15.72	10.1	12.84

German Observations in the Western Baltic in 1959

(Figure 56; Tables 20–21)

Daily surface observations (at 8^h MET) of temperature and salinity have been made in 1959 by 3 German lightvessels in the manner in which it has been done since 1949. (For positions, see Ann. Biol., 14, p. 90.) The data will be published in full in "Meereskundliche Beobachtungen und Ergebnisse". Monthly means of the observations are given in Table 20 in comparison with the ten-year means 1950/59. Hydrographical subsurface observations were made daily at the "Fehmarnbelt" only.

The observations made at the "Kiel" and "Flensburg" illustrate the conditions in the western parts of the Baltic in which there are no strong currents; the observations at the "Fehmarnbelt"

cover regions in which both in-going and out-going currents occur.

Surface and bottom temperatures were comparatively high nearly the whole year compared with the ten-year period 1950/59. Surface salinities had positive anomalies (referred to 1950/59), for instance, in March, June, and July. Negative anomalies have been computed for February, April, May, August, September, and November/December.

Positive anomalies of the bottom salinity occurred in January, April/June, August, and November; negative anomalies in February/March, July, September/October, and December.

On the whole it is very remarkable that the annual means of surface temperature and salinity (Table 21) at all three lightvessels show positive

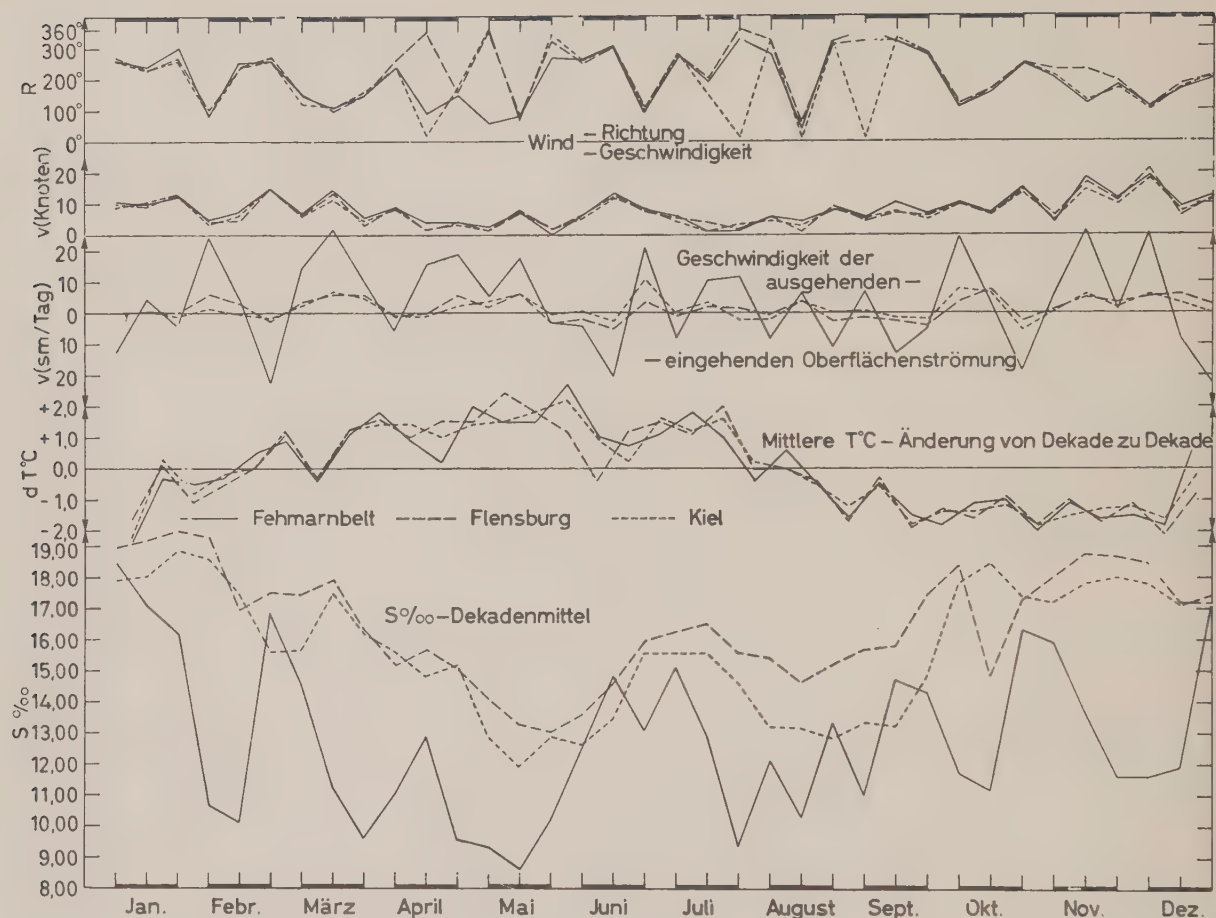


Figure 56. The situations of wind, current, temperature, and salinity at the surface in 1959 (expressed by ten-day means).

anomalies of $t^{\circ}\text{C}$ and negative anomalies of $S^{\circ}_{\text{‰}}$, referred to 1950/59. That means, in connexion with increased surface temperatures especially in spring and summer the outflow was predominant during the whole year. Figure 56 presents the situations of wind, current, temperature, and salinity at the surface in 1959 expressed by ten-day means. At first the curves of all hydrographic elements show a good accord with one another. The out-going current was predominant, for instance, in February/March, May, July, October, and December. Simultaneously a strong decrease of surface salinity occurred with this increased outflow.

The notable feature of the meteorological situations in the area of western Baltic was a considerable meridional atmospheric circulation.¹⁾ A region

of increased pressure was centred in Europe over Scandinavia and an area with decreased pressure over the North Atlantic Ocean.

This situation resulted in an additional air current from south and an anticyclone over Western, Central, and Northern Europe. The heat budget of air and water was high throughout the year. During the months mentioned above, in which the out-going current was predominant, the general weather conditions with north-eastern and south-eastern winds assisted the outflow at the surface of the western Baltic.

E. GOEDECKE

¹⁾ Deutscher Wetterdienst: Die Großwetterlagen Mitteleuropas, 12. Jg., Offenbach a. M. 1959.

Table 22. Monthly means of salinity and temperature in 1959 at surface and bottom at Swedish lightships with deviations from the 30-year means

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Salinity	Surface											
"Sydstbrotten"	—	—	—	—	5.0	5.0	5.0	5.2	5.3	5.2	5.8	5.8
Deviation	—	—	—	—	+0.1	+0.3	+0.7	+0.9	+0.7	+0.3	+0.6	+0.5
"Finngrundet"	5.8	—	—	(5.8)	5.6	5.7	5.8	5.8	5.8	5.7	5.7	6.0
Deviation	+0.4	—	—	+0.3	+0.2	+0.2	+0.4	+0.5	+0.6	+0.4	+0.3	+0.7
"Svenska Björn" ...	6.7	6.5	6.2	6.5	6.1	6.0	5.8	6.0	6.5	6.4	6.6	6.7
Deviation	+0.5	+0.3	0.0	+0.4	+0.2	+0.3	+0.3	+0.5	+0.9	+0.5	+0.5	+0.6
"Falsterborev"	8.6	8.3	(7.9)	7.6	7.4	7.6	7.8	7.6	8.1	8.0	8.6	8.5
Deviation	+0.4	+0.2	+0.1	+0.1	0.0	+0.1	-0.1	-0.3	+0.1	-0.4	+0.3	+0.2
"Oskarsgrundet" ...	13.8	13.7	8.6	10.1	8.1	11.3	8.7	10.7	10.4	11.2	9.2	11.2
Deviation	+2.7	+2.4	-1.6	+0.6	-0.3	+1.5	-1.2	+1.1	-0.4	-0.6	-1.3	-0.8
	Bottom											
"Sydstbrotten"	—	—	—	—	5.9	6.0	6.0	6.0	6.2	6.0	5.8	5.9
Deviation	—	—	—	—	+0.3	+0.4	+0.3	+0.3	+0.6	+0.4	+0.2	+0.3
"Finngrundet"	5.8	—	—	(5.6)	5.8	5.8	5.8	5.8	5.8	5.7	5.7	6.0
Deviation	0.0	—	—	-0.1	+0.1	+0.1	0.0	+0.1	0.0	0.0	0.0	+0.3
"Svenska Björn" ...	6.9	7.1	7.0	6.9	6.8	7.0	6.8	6.7	8.0	7.1	6.9	6.8
Deviation	0.0	+0.4	+0.2	+0.1	0.0	-0.4	-0.5	-1.0	+0.8	-0.2	0.0	0.0
"Falsterborev"	8.6	8.4	(8.1)	7.7	7.4	7.7	7.8	7.7	8.4	8.1	8.8	8.6
Deviation	+0.1	+0.1	+0.3	+0.1	-0.1	+0.1	-0.3	-0.5	+0.2	-0.6	+0.5	+0.1
"Oskarsgrundet" ...	13.8	13.8	11.7	11.7	11.1	15.0	9.4	12.7	12.8	15.9	12.3	19.7
Deviation	+0.2	0.0	-1.9	-0.7	+1.3	+2.8	-2.1	+1.9	+0.1	+1.9	-1.8	+5.2
Temperature	Surface											
"Sydstbrotten"	—	—	—	—	4.9	9.6	14.8	16.0	8.5	6.7	4.8	3.2
Deviation	—	—	—	—	+0.5	+1.2	+0.7	+0.6	-2.4	-1.0	0.0	0.0
"Finngrundet"	1.4	—	—	(1.0)	4.4	8.8	14.6	17.7	11.7	9.8	7.1	4.2
Deviation	-0.2	—	—	-0.3	+1.2	+1.5	+0.8	+2.1	-0.4	+1.8	+2.0	+1.2
"Svenska Björn" ...	2.4	0.6	1.1	2.2	5.8	10.0	15.6	18.2	11.7	9.7	7.5	4.8
Deviation	0.0	-0.6	0.0	+0.5	+1.6	+1.1	+0.9	+2.4	-1.4	+0.7	+0.9	+0.5
"Falsterborev"	3.1	1.8	2.5	4.7	8.8	13.5	17.4	19.6	16.7	13.3	9.6	5.1
Deviation	+0.2	0.0	+0.5	+1.0	+1.0	+1.1	+1.6	+3.1	+2.0	+1.6	+1.2	0.0
"Oskarsgrundet"	3.1	1.8	2.7	5.2	9.6	14.4	17.7	19.0	16.6	12.8	9.3	5.3
Deviation	+0.3	-0.1	+0.5	+0.9	+1.2	+1.3	+1.6	+2.3	+1.8	+1.4	+1.3	+0.6
	Bottom											
"Sydstbrotten"	—	—	—	—	1.3	1.9	2.4	2.2	2.8	3.2	4.9	3.7
Deviation	—	—	—	—	-0.5	-0.1	+0.1	-0.4	-0.8	-3.0	-0.5	-0.4
"Finngrundet"	1.5	—	—	(0.9)	3.4	4.4	5.6	6.8	10.2	9.4	7.2	4.3
Deviation	-0.1	—	—	-0.2	+0.6	-0.1	+0.4	+1.5	+4.4	+2.9	+2.1	+1.4
"Svenska Björn" ...	2.8	1.9	2.0	2.2	2.8	3.9	5.1	6.6	6.2	7.3	7.4	4.8
Deviation	+0.1	+0.3	+0.7	+1.0	+0.4	+0.7	+1.3	+1.3	+0.6	+1.0	+1.3	+0.2
"Falsterborev"	3.0	1.9	2.5	4.7	8.4	13.0	16.9	19.3	16.8	13.2	9.6	5.2
Deviation	+0.1	+0.1	+0.5	+1.1	+0.9	+1.2	+2.3	+3.6	+2.2	+1.5	+1.2	+0.1
"Oskarsgrundet" ...	3.5	2.0	2.7	5.1	9.0	14.0	17.3	18.5	16.6	13.3	10.0	6.9
Deviation	+0.1	-0.4	+0.2	+0.8	+0.9	+1.5	+1.5	+2.0	+1.9	+1.8	+1.6	+1.6

Observations at Swedish Lightvessels and in the Central Baltic

(Tables 22-23)

The salinity in the Bothnian Sea is still increasing. The annual mean increase at "Finngrundet" light-vessel is $0.4^0_{\text{‰}}$ at the surface and $0.1^0_{\text{‰}}$ at the 30 m level. Salinity in the greater depths of Landsort Deep and Gothland Deep is, however, still decreasing. The stagnation process there can also be studied by the decreasing values of oxygen and increasing values of phosphate. In the Bornholm

Deep, however, intrusions of Kattegat water have occurred. The oxygen content at 80 m depth was more than 2 ml/litre in November.

The surplus heat in the surface water at most lightvessels and at most times can be studied especially through the following mean deviations:—

	t°C		t°C
"Sydstbrotten" ..	-0.1	"Falsterborev" ..	+1.1
"Finngrundet" ..	+1.0	"Oskarsgrundet" ..	+1.1
"Svenska Björn" ..	+0.6		

ARTUR SVANSSON

Table 23. Hydrographic data of the deep basins of the Baltic in 1959

Bornholm Deep 55°15'N, 15°59'E					Gothland Deep 57°21'N, 19°57'E					
Depth m	Temp. °C	S ‰	O ₂ ml/litre	PO ₄ -P μg-at./litre	Depth. m	Temp. °C	S ‰	O ₂ ml/litre	PO ₄ -P μg-at./litre	Alkal. mean val./litre
3. February					2. February					
000	3.05	7.49	—	0.17	000	3.38	7.56	—	0.21	—
020	5.04	7.50	—	0.13	070	3.34	9.07	3.87	0.50	—
030	3.10	7.56	8.70	0.13	150	5.31	12.28	0	4.1	—
050	6.71	10.46	5.28	0.36	200	5.67	12.92	0	6.5	—
060	8.33	12.20	—	0.50	220	5.65	12.96	0	7.0	—
080	7.05	13.73	1.84	1.38						
087	6.76	14.07	1.09	1.60						
16. April					16. April					
000	3.49	7.47	9.17	0.06	000	3.49	7.51	8.88	0.13	1.54
060	5.18	10.47	5.50	0.41	070	3.54	8.79	4.29	0.61	1.59
080	6.28	14.94	1.88	1.21	150	5.24	12.12	0	4.2	1.79
					200	5.74	12.94	0	7.2	1.79
					225	5.70	13.07	0	8.8	—
20. October					31. July					
000	13.52	7.50	6.86	0.14	000	19.58	7.16	6.46	—	—
040	6.31	7.62	6.94	0.14	020	10.81	7.36	7.22	—	—
050	10.15	9.93	4.99	0.27	070	3.40	7.67	7.25	—	—
070	13.26	13.61	3.26	0.50	150	5.30	12.28	0.34	—	—
080	5.56	14.41	2.12	0.68	200	5.64	12.88	0	—	—
087	5.21	14.63	1.63	0.83	220	5.68	12.92	—	—	—
12. November					21. October					
000	9.98	7.43	—	—	000	10.48	6.82	7.45	0.05	—
050	6.34	7.72	6.11	—	070	3.53	7.91	6.24	0.24	—
060	10.03	12.12	3.98	—	150	5.32	12.20	0	4.3	1.79
070	12.78	14.42	3.04	—	200	5.60	12.85	0	9.5	1.87
080	9.04	14.85	2.14	—	231	5.38	12.97	0	10.6	1.97
088	8.83	15.20	1.79	—						

Landsort Deep
58°35'N, 18°14'E

Depth m	Temp. °C	S ‰	O ₂ ml/litre	PO ₄ -P μg-at./litre
2. February				
000	2.53	7.23	—	0.24
070	3.72	8.47	5.17	0.54
400	4.61	10.72	0.35	1.46
430	4.58	10.72	0.32	1.50
18. April				
000	3.03	7.20	9.36	0.08
070	3.65	8.54	5.18	0.63
400	4.77	10.67	0.31	1.61
425	4.56	10.67	0.30	1.61
3. August				
000	19.36	6.78	—	—
030	8.74	6.97	—	—
070	3.35	8.39	4.81	—
400	4.44	10.60	0.31	—
455	4.44	10.60	—	—
4. November				
000	9.82	7.08	—	—
070	3.73	9.21	2.40	—
400	4.49	10.56	0.25	—

1959

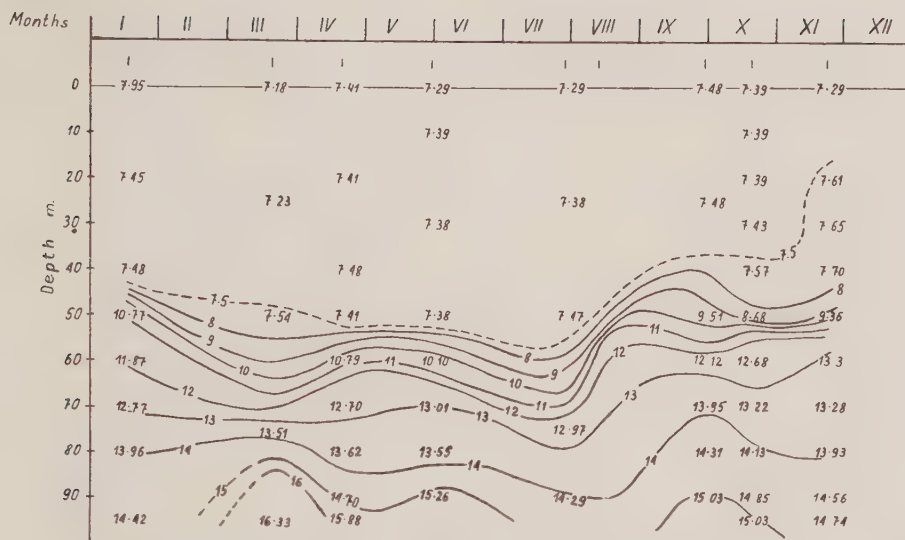


Figure 57. Salinity in Bornholm Deep (55°19'N, 15°44'E).

Polish Observations in the Southern Baltic in 1959

(Figures 57-64)

The location of the fixed hydrographical stations was the same as in previous years. The observations concerned temperature, salinity, oxygen, and phosphate content. Figures 57-64 present the distribution of these hydrographical features in Bornholm and Gdansk Deeps.

Salinity (Figs. 57 and 58)

The range of surface salinity in Bornholm Deep was between 7.18^{0}_{00} and 7.48^{0}_{00} . The upper water layer limited at the bottom by the 8^{0}_{00} isohaline was of 40-60 m thickness. The bottom salinity oscillated in the region of 2^{0}_{00} , the maximum (16.33^{0}_{00}) being observed in March, the minimum (14.29^{0}_{00}) at the end of July. The salinity in November was 0.3^{0}_{00} higher than that observed there at the beginning of the year.

1959

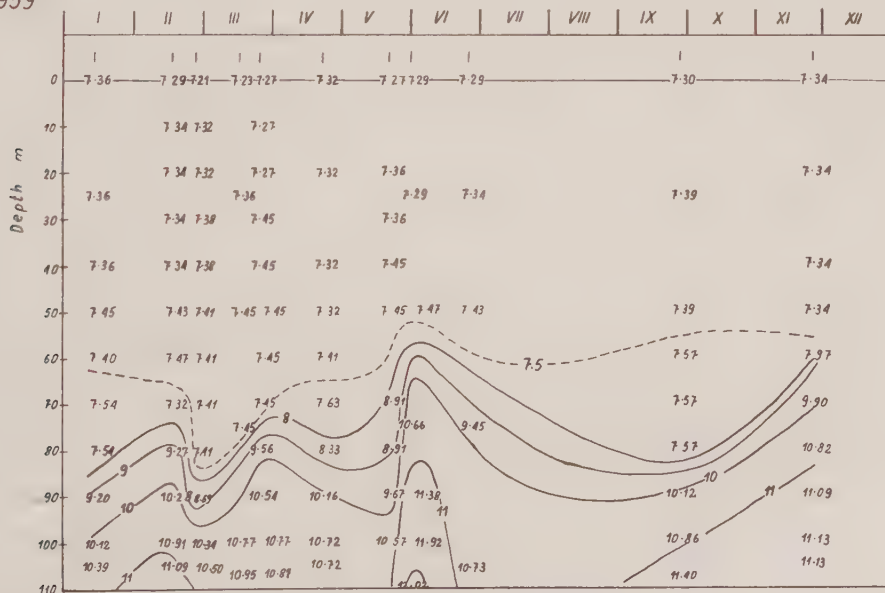


Figure 58. Salinity in Gdansk Deep.

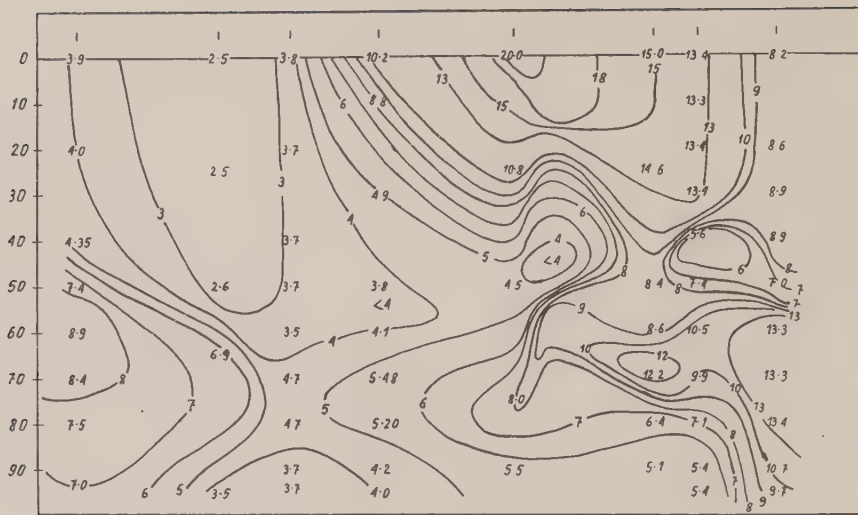


Figure 59. Temperature in Bornholm Deep.

The surface salinity of Gdansk Deep remained at the same level throughout the year (about $7.3^{0/00}$); the $8^{0/00}$ isohaline was encountered between 85 m (February) and 55 m (June). Generally; all isohalines in Gdansk Deep were often found at different depths and inside wide limits. The bottom salinity continued to be rather low, although intrusions of water with salinity above $11^{0/00}$ occurred three times. By the end of the year some improvement of the conditions was observed, the salinity at that time being somewhat above $11^{0/00}$ in comparison with the $10.4^{0/00}$ recorded in January.

Temperature (Figs. 59 and 60)

The winter 1958/59 may be regarded as medium cold. The minimum temperature in Bornholm Deep (2.5°C) was observed in March. The cold winter water with temperature below 4°C prevailed at the depth of about 40 m until June, but a somewhat warmer water body seems to have remained until November. The summer being exceptionally long and hot the maximum temperature of the surface waters ($20.0^{\circ}\text{—}21.75^{\circ}\text{C}$) was registered at the end of July. The lowest winter temperature, measured in February and March in

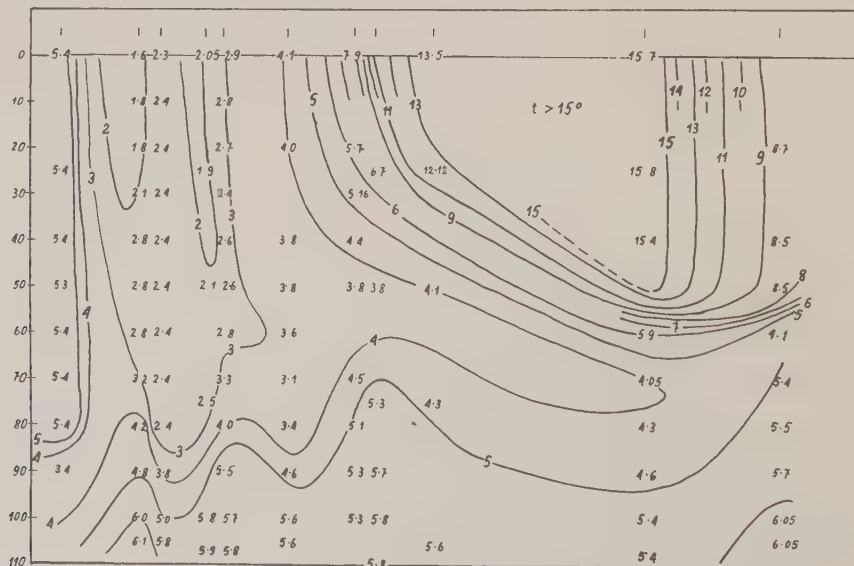
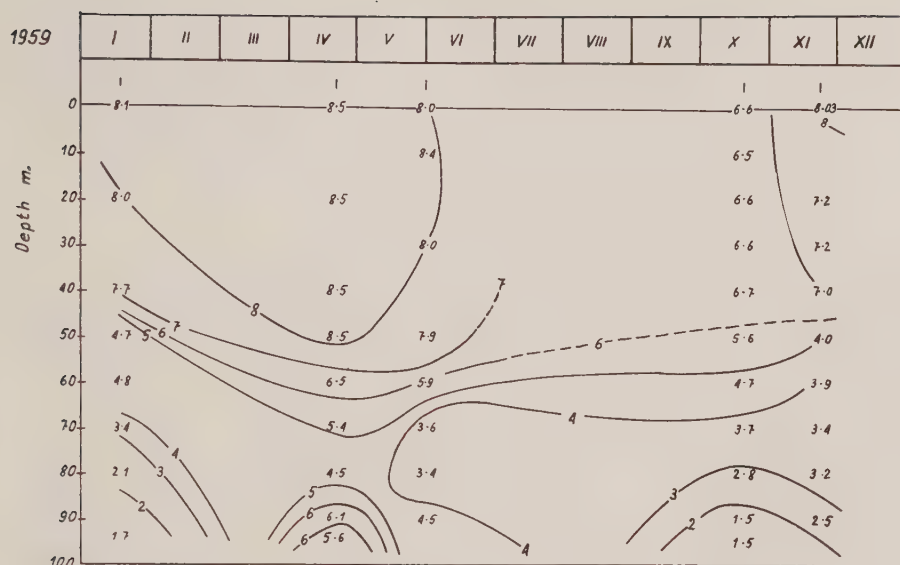


Figure 60. Temperature in Gdansk Deep.

Figure 61. Oxygen content, O_2 ml/l, in Bornholm Deep.

Gdansk Deep, was 1.6°C . As we have no observations from Gdansk Deep for July and August the maximum temperature there has not been registered. The winter water (below 4°C) was still observed there in September, the water of $4^\circ\text{--}5^\circ\text{C}$ prevailed, however, until November.

The bottom temperature in Bornholm Deep varied greatly, as is shown in Figure 59. As regards the water layer below 80 m depth the temperature extremes were 3.5°C and 13.4°C , thus a difference

of almost 10°C ! Such a phenomenon is very rare, even in the Bornholm Deep. Attention must be drawn to the intrusion of a vast volume of warm water that took place in the second half of the year, evidenced by the exceedingly complicated distribution of isotherms at depths below 40 m. The temperature of the bottom water in Gdansk Deep was rather constant ($4^\circ\text{--}6^\circ\text{C}$) throughout the year, except in January when 3.4°C was recorded.

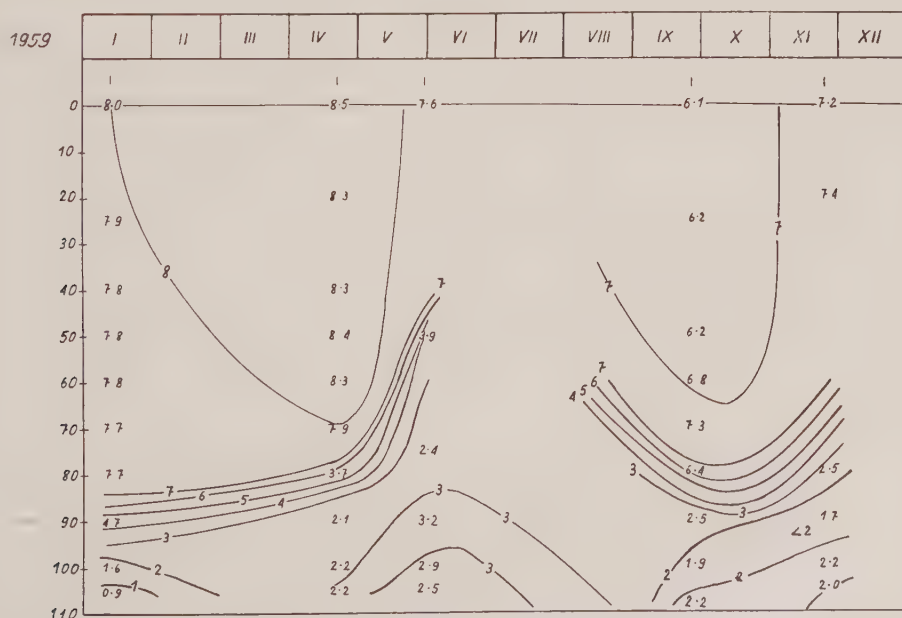


Figure 62. Oxygen content in Gdansk Deep.

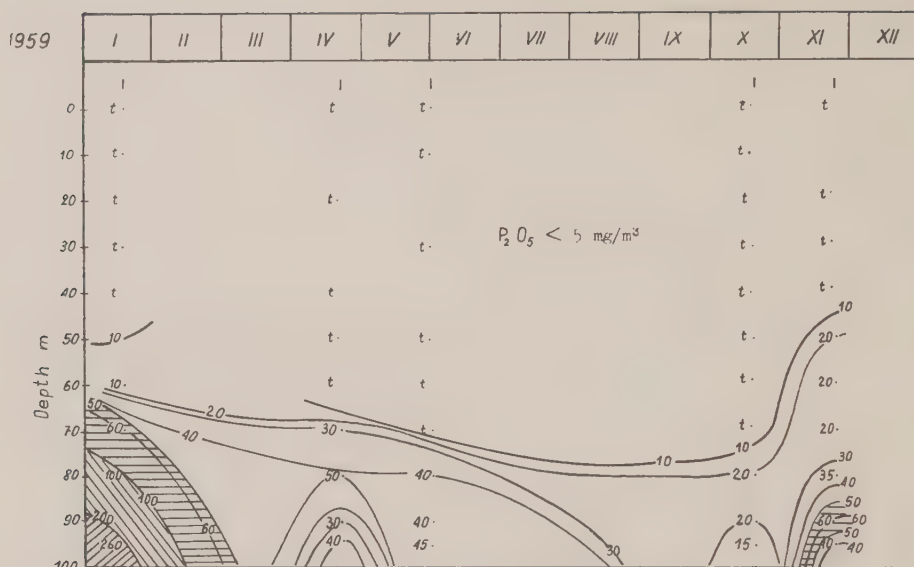


Figure 63. Phosphate content, P_2O_5 mg/m³, in Bornholm Deep.

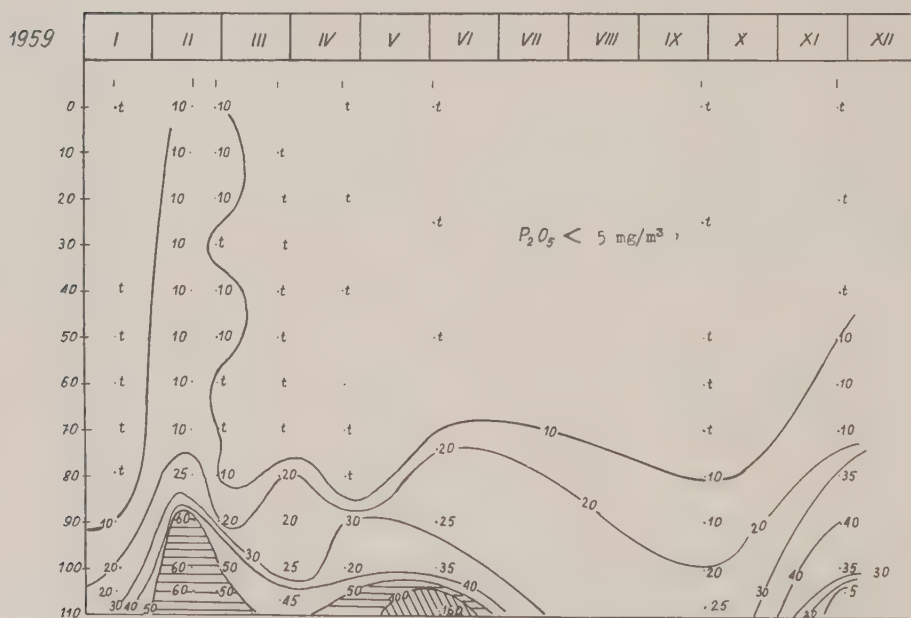


Figure 64. Phosphate content in Gdansk Deep.

Oxygen content (Figs. 61 and 62)

The amount of dissolved oxygen in the bottom layer was rather low in both the Deeps, values of 1.5, 1.7, and 0.9 ml/l being observed. However, in Bornholm Deep the conditions improved somewhat in April (5.5 ml/l) but for a short period only. By the end of the year 1.5 ml/l was again observed.

Phosphate distribution (Figs. 63 and 64)

At the bottom of Bornholm Deep a high phosphate content (about 260 mg P_2O_5 per m³) was observed at the beginning of the year, evidently connected with the exceedingly high phosphate content (over 600 mg/m³) found there in November 1958. In March, however, the phosphate values

were only 40—50 mg/m³ and with small deviations it was declining towards the end of the year.

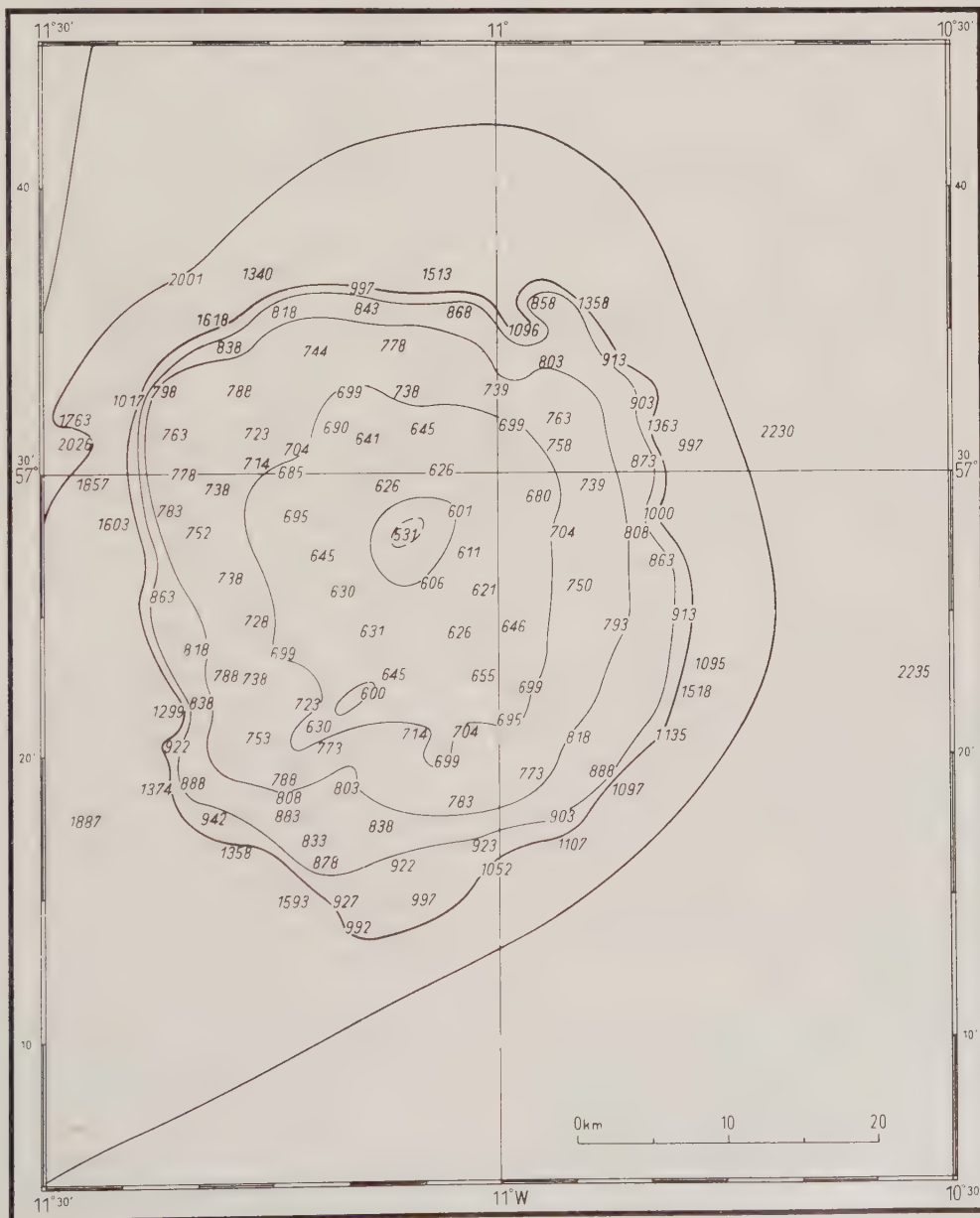
In Gdansk Deep the phosphate concentration was also greater in the first half of the year than later on, the maximum, in the region of 160 mg/m³, being observed in June, whereupon a gradual decrease took place.

Throughout the year, February excepted, the isohalinic upper water layers showed traces of phosphate, only in February in Gdansk Deep (and probably also in Bornholm Deep) the content amounted to about 10 mg/m³.

A. GLOWINSKA

D. L'Atlantique

Results of Hydrographic Investigations between St. Kilda and Rockall Bank in April 1959



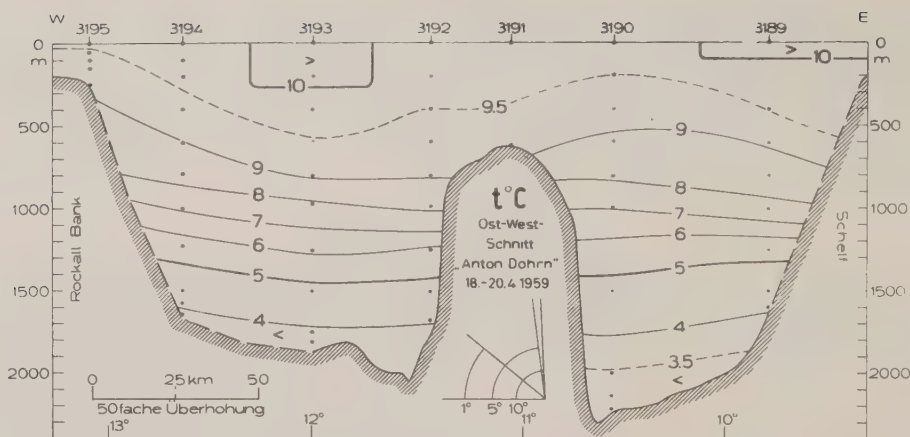


Figure 66. Temperature distribution on an east-west profile between St. Kilda and Rockall Bank (stations 3189—3195). The stations are in the following positions:—

No. 3189 = $57^{\circ}23'N$, $09^{\circ}48'W$. No. 3195 = $57^{\circ}36'N$, $13^{\circ}06'W$. Dates of observation, 18.—19. April 1959.

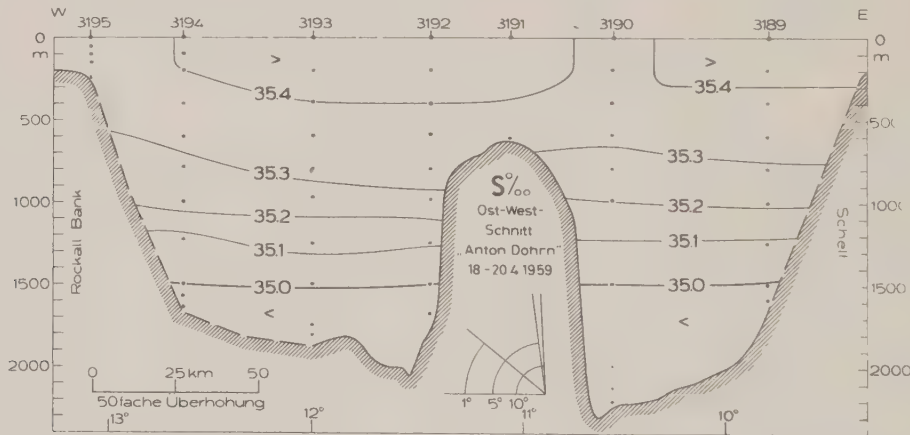


Figure 67. Salinity distribution between St. Kilda and Rockall Bank. For further explanation, see Fig. 66.

In the period 14. April to 13. May 1959 the R/V "Anton Dohrn" operated in the waters of the North-East Atlantic (Rockall Bank, Iceland, Iceland-Faroe Ridge, and the small banks west of the Faroe Islands). On this cruise hydrographic investigations were carried out at 76 stations. 452 water samples were taken for salinity determination.

The present contribution only concerns the results of the hydrographic investigations between the Hebrides and Rockall Bank.

In September 1958, R/V "Gauss" crossed a submarine peak between Rockall Bank and St. Kilda which so far was unknown. Details of the topography of this elevation were obtained by 10 echo-sounding profiles across it (Fig. 65). On the fairly even central part of the bank a trawl haul was made between $57^{\circ}23'N$, $11^{\circ}04'W$ and $57^{\circ}27'N$, $11^{\circ}03'W$ at 610—620 m depth. The maximum elevation of the bank was sounded at $57^{\circ}28'N$,

$11^{\circ}05'30''W$ showing a peak of 531 m, surpassing its surroundings by about 70 m.

The temperature and salinity distribution of an east-west profile between stations Nos. 3189 and 3195 are shown in Figures 66 and 67. Two main water masses may be clearly distinguished:—

(a) The oceanic water down to 1,500 m depth. It is limited by the 35°_{00} isohaline corresponding to the 5° isotherm. The Atlantic current is limited by the 35.4°_{00} isohaline and goes down to 400 m. The maximum temperature at the surface was $10.3^{\circ}C$ at station 3193 on 19. April 1959. The corresponding salinity value was 35.44°_{00} .

(b) The sub-ocean water mass was formed by a turbulent mixture of oceanic water and bottom water of the Norwegian Sea. The maximum temperature ($3.34^{\circ}C$) was recorded near the bottom at station 3190. The salinity values vary between 34.94°_{00} and 34.99°_{00} .

E. ROGALLA

PART II.

PLANKTON AND BENTHOS

A. Distant Northern Seas

Dry Weight of Plankton in the Western Barents Sea 1957—1959

(Figure 1; Tables 1-4)

Plankton sampling from the "Ernest Holt" in the last three years has been similar to that described in my last report (Ann. Biol., 13: 39-40). Figure 1 shows the lines of stations which have been worked at various times between 1957 and 1959. The numbering of the lines is the same as in the previous report with some additions. Numbers 9 and 15 represent sampling on the banks and over deep water west of Spitsbergen south and north of 78°30'N respectively. Each line has between four and ten stations, not all of which are worked on each cruise because of limitations of weather, ice, and time. The net of No. 3 bolting silk has a conical top piece with rings of 40 cm and 50 cm diameter. It is hauled vertically from the bottom to the surface where the bottom is deeper than 600 m. The samples are dried and weighed as described by WIMPENNY (Ann. Biol., 4: 89-90).

The results are presented in Tables 1 and 2 as dry weight in grammes under 1 square metre. For each line on each cruise the mean of the separate stations is taken. The cruise means in the last column of Table 1 are the means of the figures for each line.

The dates of the cruises and the number of the stations worked vary from year to year, but from

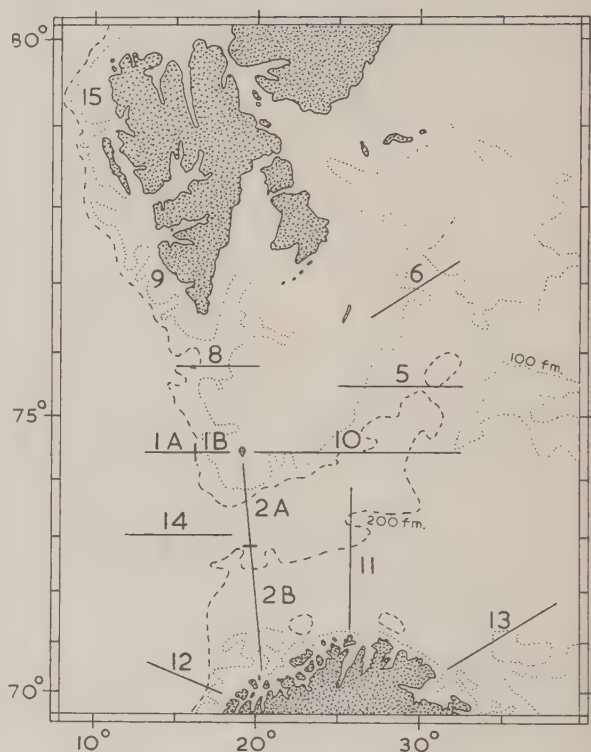


Figure 1. Lines of plankton stations worked by R.V. "Ernest Holt" between 1957 and 1959.

Table 1. Dry weight of plankton in the north-western Barents Sea in grammes under 1 square metre
(Figures in brackets are means of two stations only)

Line	15	9	8	1A	1B	14	2A	10	5	6	Mean
1957											
April-May	11.6	—	2.5	8.0	2.8	11.5	3.3	6.0	—	—	6.5
June-July	12.0	—	7.3	18.3	7.8	—	8.5	—	—	—	10.8
August	—	—	—	14.1	13.6	—	21.1	15.1	—	—	16.0
October	—	—	8.5	—	6.4	—	12.7	—	16.6	7.2	10.3
Nov.-Dec.	—	—	—	5.2	4.2	—	8.8	12.4	—	—	7.6
1958											
March	—	—	—	—	—	—	5.8	—	—	—	5.8
May	—	—	—	—	—	—	11.8	—	—	—	11.8
June-July	—	8.6	—	12.8	7.2	—	25.3	—	—	—	13.5
August	9.8	14.7	—	17.1	22.4	—	21.0	—	—	—	17.0
October	—	—	—	12.3	8.0	—	15.7	—	(18.3)	—	13.6
November	—	—	—	7.1	—	—	—	—	—	—	7.1
1959											
April	—	—	4.6	14.0	4.4	—	4.3	—	—	—	6.8
June	—	14.5	—	19.4	4.8	—	12.4	—	—	—	12.8
July	—	11.1	—	25.9	9.3	—	14.4	—	—	—	15.2
Aug.-Sept.	—	—	—	—	—	—	13.6	—	—	—	13.6
October	(7.9)	(3.5)	—	12.5	6.9	—	9.3	—	—	—	8.0
December	—	—	—	11.5	8.8	—	—	—	—	—	10.2

Table 2. Dry weight of plankton in the south-western Barents Sea in grammes under 1 square metre

Line	12	2B	11	13
1957				
April–May	8.6	3.5	5.4	—
August	7.8	9.8	19.9	—
November–December . .	4.5	(2.4)	—	7.3
1958				
February	(4.4)	—	—	—
March	4.0	—	—	—
April	(7.2)	—	—	—
June	20.7	(11.1)	—	—
1959				
January	4.9	—	—	—

Table 3. Stations west and south of Bear Island

	Number of stations	Dry weight mg per m ³
1957		
1–9. May	14	13
28. June–3. July	13	37
24. –25. August	12	51
22.–23. October	7	45
29. November–1. December . .	14	21
1958		
14. May	5	32
25. June–2. July	12	43
18. –19. August	12	61
11.–12. October	11	40
1959		
17.–22. April	11	22
4.–6. June	13	31
15.–25. July	12	46
31. August–1. September . . .	4	43
7.–8. October	12	27
7.–8. December	9	28

Table 4. Plankton dry weight means for 1953 to 1959

Year	NW Barents Sea May/September g/m ²	Bear Island mid-April/September mg/m ³
1953	10.4	26
1954	14.5	46
1955	7.9	24
1956	9.4	29
1957	11.1	34
1958	14.1	45
1959	13.9	36
Mean	11.6	34

Table 1 the year 1958 seems to have had a higher standing crop than the other two, particularly in late summer and autumn. The means of the cruise means for the three summer cruises between May and September each year are:—

	1957	1958	1959
g/m ²	11.1	14.1	13.9

The lines west and south of Bear Island (1A, 1B, and 2A) have been worked more regularly than the

others and in previous reports (Ann. Biol., 9 and 13) the dry weight in this area has been reported as milligrammes per cubic metre. Table 3 gives these figures for the cruises between 1957 and 1959.

In Table 4 the means of the cruise means for cruises between mid-April and the end of September are presented for the seven years in which the same methods of working have been used, together with the means of the three summer cruises over the wider area described above. Table 4 shows that in the Bear Island area the years 1954 and 1958 stand out as years with above average standing crop, 1957 and 1959 are about average, and 1953, 1955, and 1956 below average.

JOHN CORLETT

Soviet Plankton Investigations in the Norwegian Sea in 1959

(Figures 2–3; Table 5)

In 1959 the plankton sampling was carried out from Soviet research vessels and from Herring Fisheries Reconnaissance Ships over the whole Norwegian Sea.

Samples of plankton were treated by PAVSHTIKS and TIMOHINA (PINRO) and by GRUZOV and VINOGRADOVA (BALTNIRO).

The forecasts of the feeding conditions for herring were made during the spring/summer season, and characteristic features of the plankton development were observed.

As usual in January and February, the plankton was poor. In March/April *Calanus finmarchicus* and Euphausiacea spawn in the southern Norwegian Sea. They are eaten by herring migrating off the Norwegian coast after spawning. However, more than 50% of the herring had empty stomachs.

Rough weather in April hindered the development of phytoplankton. Maximum development of phytoplankton was observed in May. *Phaeocystis* was rich off the Lofotens and in the East Icelandic Current, and diatoms developed in the southern and central areas.

One of the characteristic features of 1959, also observed in 1958, was an extended distribution of *Calanus hyperboreus* in the western and northern parts of the Norwegian Sea in May/June. *Calanus hyperboreus* was very rich at the stations of the northern sections along latitude 71°10', 72°50', and 74°30'N.

But these good feeding conditions were poorly used by the herring. The best feeding conditions in May/June were to the north of the Faroes along the eastern limit of the East Icelandic Current. Almost all the herrings there had food in their stomachs.

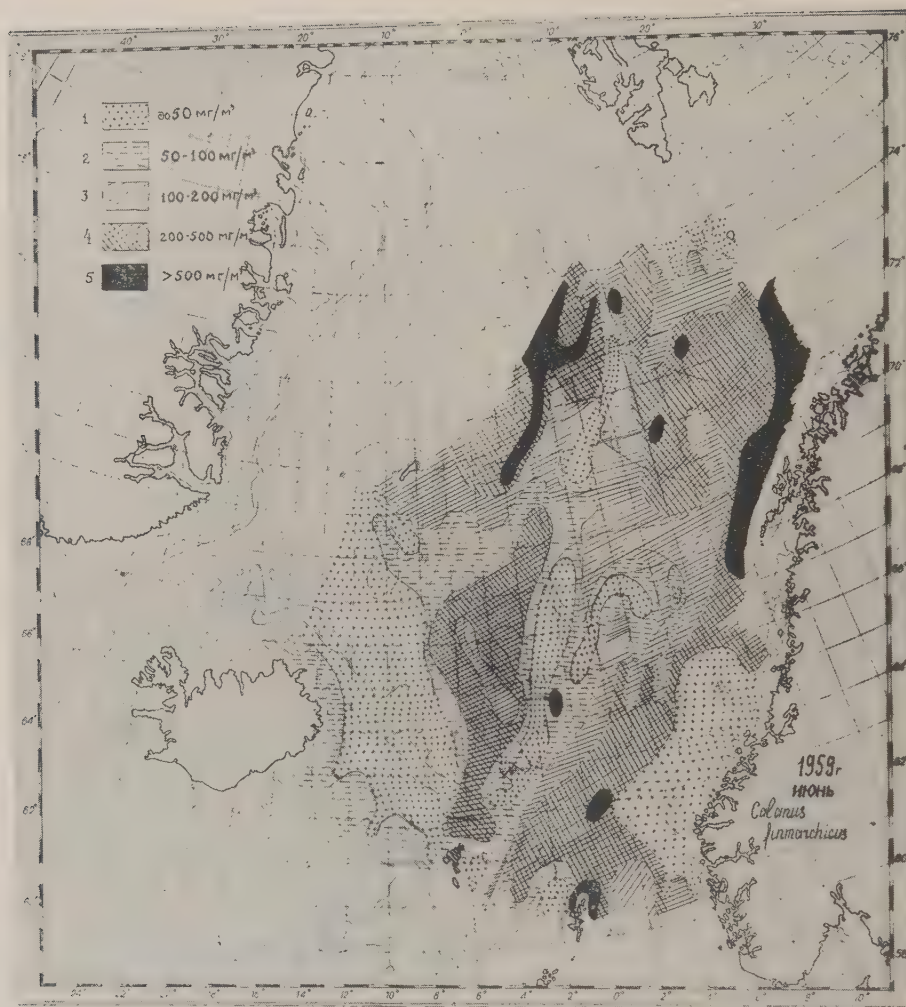


Figure 2. Quantitative distribution of *Calanus finmarchicus* in the Norwegian Sea in the 50-0 m layer in June 1959. (The biomass of *Calanus finmarchicus* is calculated according to the table of mean weights made by KANAIEVA (VNIRO).)

Explanation of symbols: 1, up to 50 mg/m³; 2, 50 to 100 mg/m³; 3, 100-200 mg/m³; 4, 200-500 mg/m³; 5, more than 500 mg/m³.

The main food organism of herring was *Calanus finmarchicus*. The quantitative distribution of *Calanus finmarchicus* in the waters of different origin is very interesting to study. *Calanus finmarchicus* was very abundant in the Lofoten area and westwards in the mixed waters in June (Fig. 2).

In the waters of the Norwegian Current *Calanus finmarchicus* (copepodite stages IV-V, "red *Calanus*") predominated in June. In the mixed waters *Calanus* was a little younger, the bulk was formed by *Calanus finmarchicus* (copepodite stages III to IV). In the East Icelandic Current the spawning of *Calanus* is at its height in June. Especially plentiful were nauplii and copepodite stages I-II.

Table 5. Mean biomass of plankton in the waters of the Norwegian Current in the 50-0 m layer in June (in mg/m³)

Sections	1951	1958	1959
74°30' N	225	1021	525
72°50' N	—	1600	978
71°10' N	552	1183	831
69°20' N	483	1736	1100

Figure 3 shows changes in the age composition of the population of *Calanus finmarchicus* as moving off the Norwegian coast westwards and north-westwards. The changes in the stages of development of *Calanus* in regard of waters of different origin are obvious.

In conclusion it should be mentioned that the total number of plankton organisms (seston) in

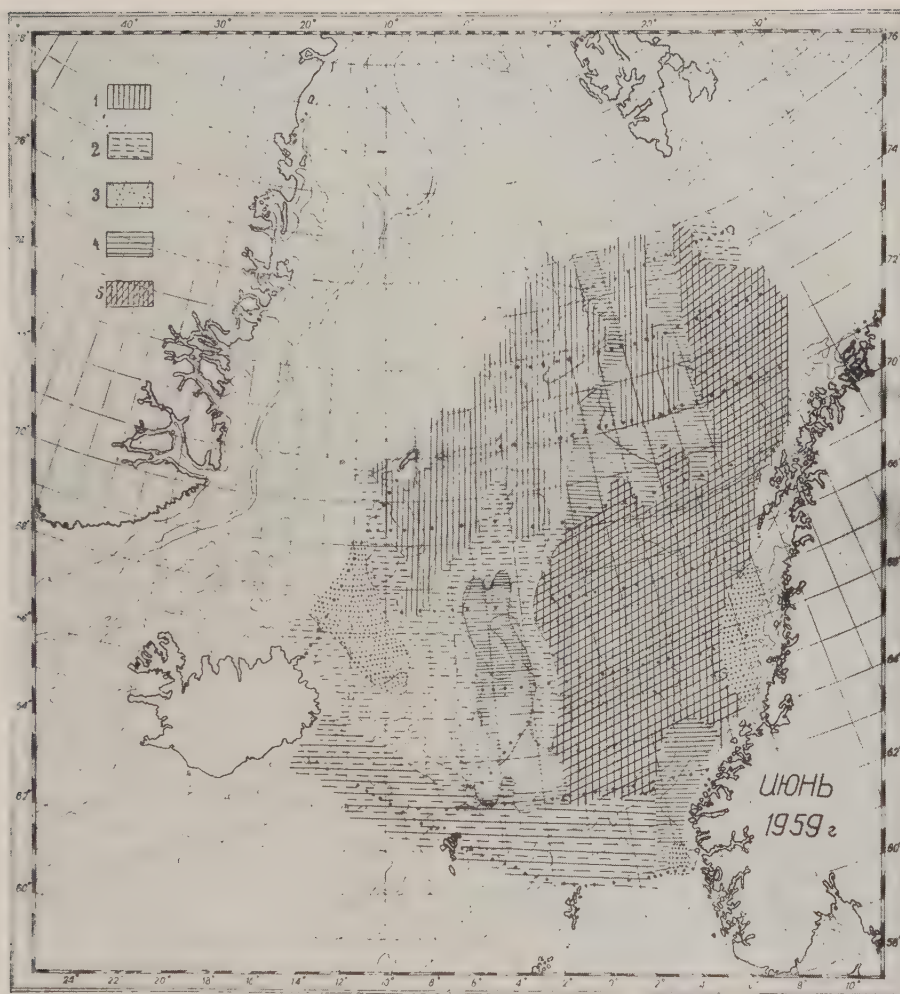


Figure 3. Distribution of different stages of *Calanus finmarchicus* in the 50-0 m layer. (Copepodite stages of *Calanus finmarchicus* forming more than 50% in the samples are shown.)

Explanation of symbols: 1, prespawning communities of *Calanus finmarchicus* (copepodite stages V-VI); 2, nauplii and copepodite stages I-II-III; 3, nauplii and copepodite stage VI; 4, copepodite stages III-IV; 5, copepodite stages IV and V.

1959 decreased as compared with that in 1958, but in the north the quantity of plankton was rather higher than in 1951, an average year for the last ten years (by the abundance of plankton). The increase of the biomass of plankton in 1958 and 1959 is explained by the presence of great numbers of *Calanus hyperboreus*, and at the stations of the section along latitude 69°20'N by the rich development of phytoplankton.

L. N. GRUZOV
E. A. PAVSHTIKS

Joint Danish, Icelandic, and Norwegian Plankton Research in the North-East Atlantic in June 1959

(Figure 4)

During the period 29. June to 1. July 1959, Danish, Faroese, Icelandic, Norwegian, and Soviet marine scientists were gathered at a meeting in Thorshavn, Faroe Islands. Material collected on the research ships "Dana", "Ægir", "Johan Hjort", "Sevastopol", "Argun", and "Professor Mesyatsev" was discussed.

The accompanying chart (Fig. 4) illustrates the density of zooplankton in the upper 50 metres in June 1959 in the area investigated.

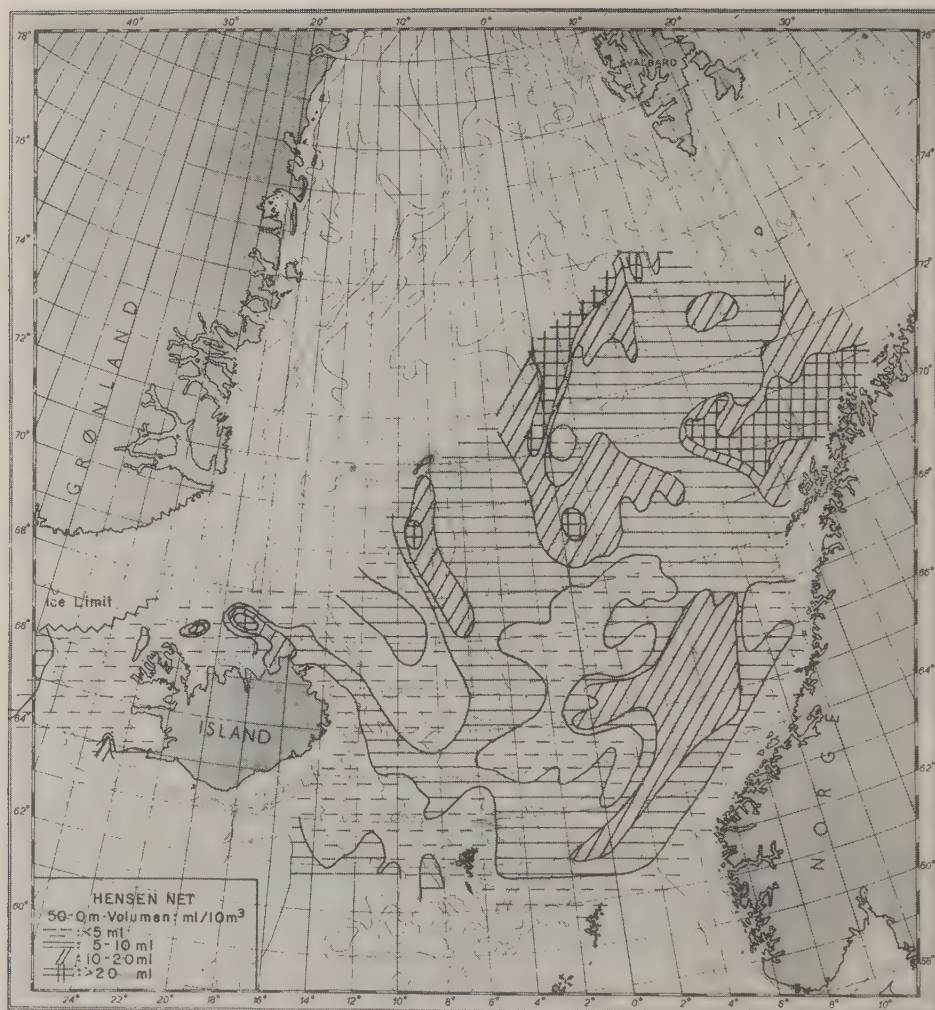


Figure 4. Density of zooplankton in the upper 50 m of the Norwegian Sea in June 1959.

In collecting the zooplankton, different types of vertical nets with different sizes of mesh were used. Therefore, the chart gives only a rough picture of the main zooplankton distribution.

Measurements of the primary production were also carried out from the Danish, Icelandic, and Norwegian research ships. Quantitative samples for taxonomic investigation of the phytoplankton were taken, but different methods were employed for determination of the standing stock of phytoplankton (chlorophyll measurements, Secchi disk readings, and continuous readings of light absorption in a particular water column).

Qualitative analysis of net plankton were carried out on board the Norwegian and the Soviet ships during the cruise.

INGVAR HALLGRÍMSSON

Sebastes in Continuous Plankton Records during 1959

(Figures 5 and 6)

Since 1957 Continuous Plankton Recorders have been used, at a depth of 10 metres and at monthly intervals, on a route extending for some 450 miles in a south-westerly direction from Reykjanes. This route (Z), combined with others (U and Y) to the south of Iceland, has revealed the presence of young stages of *Sebastes marinus* L. in April, May, and June of each year. A chart showing the Edinburgh Oceanographic Laboratory's Continuous Plankton Recorder survey is provided by GLOVER and BARNES (Figure 7 on p. 76 of this volume of the Ann. Biol.). In 1959 the Z route was extended, at first to sample for 900 miles (and, after the period

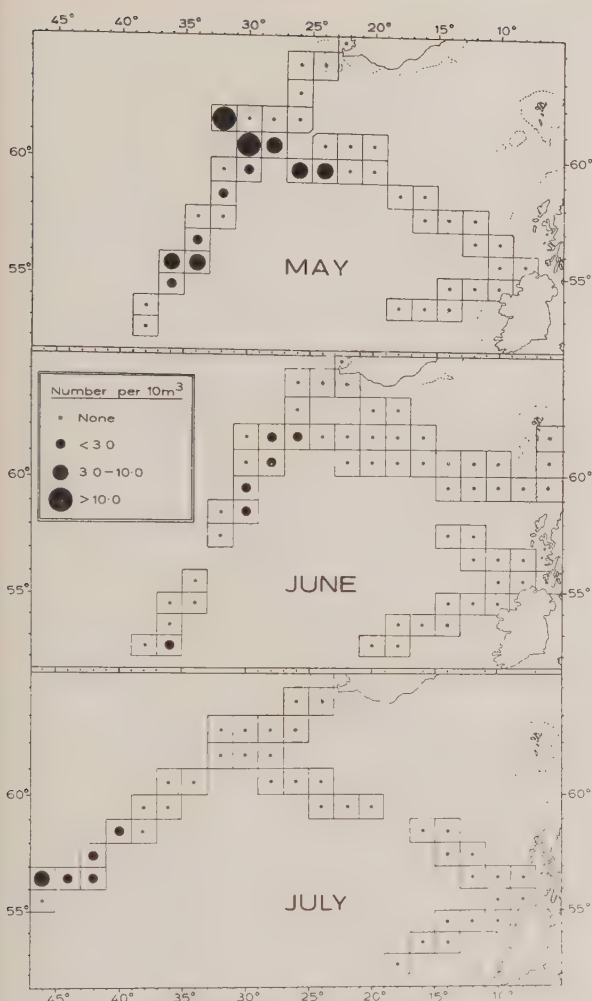


Figure 5. Charts showing the distribution of the young *Sebastes marinus* taken with the Continuous Plankton Recorder in 1959. See text for explanation.

covered by this report, to reach from Iceland to the Newfoundland Banks). The results presented here incorporate the first material collected along this extended route.

Figure 5 shows the distribution of all the young *Sebastes* taken during 1959. As in previous years, they appeared to be *S. marinus*, none showing the sub-caudal melanophores characteristic of the *mentella* type. A single specimen of *S. viviparus* Kr. was taken in June, just outside the 100 fathom contour west of Reykjanes, well separated in space from the two patches of *S. marinus*.

Because some of the routes were sampled more than once in each month it is convenient to express the results as the average number of *S. marinus* per 10 m³ sampled in statistical squares measuring

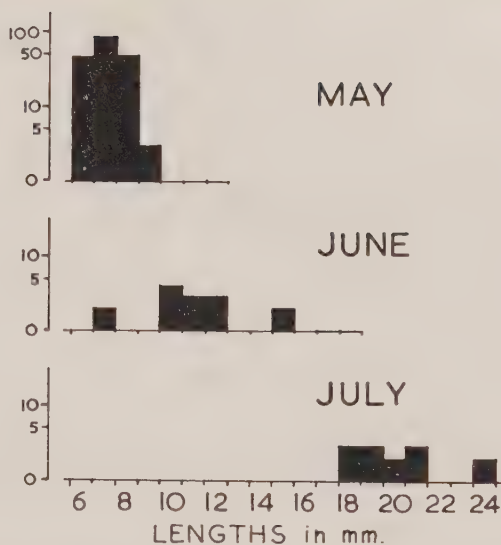


Figure 6. Size frequency histograms of the young *Sebastes marinus* taken with the Continuous Plankton Recorder in 1959. The numbers are plotted on a logarithmic scale.

1° of latitude by 2° of longitude. Only those squares which were sampled are shown in Figure 5, a small dot indicating that *Sebastes* was absent from the samples. The length frequencies in each month are shown in Figure 6.

Unfortunately no Recorder samples were taken in April in the area south and south-west of Iceland. In May *Sebastes* in the size range 6 to 9 mm were abundant, the distribution being centred on the Reykjanes Ridge and extending from 200 to 400 miles south-west of Iceland. The largest numbers (up to 19 per 10 m³) were found over the western slope of the Ridge but there was a smaller patch (up to 3.5 per 10 m³) separated from the main concentration by about 150 miles, and centred about Lat. 55°N: Long. 35°W.

Much smaller numbers were taken in June, the highest average reaching only 1.7 per 10 m³. Most of them were taken in the area of the greatest concentration in May but they were larger (10 to 12 mm, see Fig. 6). Only a trace remained of the smaller patch which was found further to the south-west in the previous month.

In July none were found in the area of the Reykjanes Ridge (although the level of sampling was comparable with the earlier months). As a result of a change in the ship's track, the area centred on Lat. 55°N: Long. 35°W was not sampled. The extended record, however, revealed the presence of *Sebastes* in an area lying between 59°N: 40°W and 55°N: 47°W which had not been sampled previously. The average number reached 3.3 per

10 m³ in one square but they were all much longer (18 to 25 mm) than any of the specimens taken in the previous months.

Although the numbers caught were very small, the length frequencies (Figure 6) were sufficiently compact to suggest that the *Sebastes* taken in the first two months belonged to the same population, the size range increasing from 6–9 mm in May to 10–12 mm in June. It seems unlikely, however, that the specimens taken in July belonged to the same population as the lengths showed a sharp jump to 18–25 mm.

An approximate comparison with earlier years suggests that *Sebastes* in the area south of Iceland were more abundant in 1959 than in 1958 but less numerous than in 1957. No specimens of *Sebastes* have been taken in the Continuous Plankton Recorder except in the months of April, May, June, and July.

An abridged account of the distribution of *Sebastes* in Recorder collections was contributed to the Redfish Symposium in October 1959 and will appear in *Rapports et Procès-Verbaux*, Vol. 150. A more detailed account is being prepared for publication in the *Bulletins of Marine Ecology*.

G. T. D. HENDERSON

Plankton Investigations from Aberdeen

Phytoplankton

In July mixed water containing *Parafavella elegans*, *Dictyocysta magna*, *Globigerina*, *Acanthometron*, and *Rhizosolenia alata* appeared to pass through the Faroe-Shetland Channel into the North Sea whilst water containing *Ptychocyclis minor*, *Thalassicolla*, *Dinophysis tripos*, and some *R. alata* appeared to move northwards towards Iceland with the more oceanic zooplankton. Over the Faroe Plateau *Nitzschia closterium* and *Chaetoceros debilis* were dominant.

In October phytoplankton was sparse in the Faroe-Shetland Channel but *R. alata* occurred over the Faroe Bank.

T. LOVEGROVE

Zooplankton

The Scottish research vessels from Aberdeen worked in the Faroe Channel area in May, July, and October, and in the region of the Faroe-Iceland Ridge in July. These cruises showed the presence of a core of Lusitanian fauna mixed with an Atlantic fauna off the edge of the continental shelf in the spring of 1959 which extended northwards through the Faroe Channel towards Shetland. The core of exotic species barely reached Shetland, though the mixed fauna at the edge penetrated beyond Shetland to the Norwegian and North Sea. The Lusitanian fauna increased in proportion until October. Details of the plankton at the southern side of the Channel are given in the report to the Near Northern Seas Committee. There was a slight leakage of this fauna, mixed with a dominant Atlantic fauna, to Faroe Bank and west of Faroe to affect the Faroe-Iceland Ridge north-west of the 100 m contour.

Little of this oceanic fauna was found on the traverses from Faroes to Shetland where the indigenous community of *Aurelia*, *Cyanea*, *Laodicea*, etc. was not replaced by oceanic exotics, except close to Shetland. *Calanus* was abundant on the Faroe Plateau in May, but later became reduced to rather small numbers.

The plankton of only the south-eastern half of the Faroe-Iceland Ridge was examined in 1959. Here, in July, *Calanus* was common only in the area between the 100 m contour and about 10°W with *Pareuchaeta norvegica* and *Thysanoessa inermis*. Otherwise crustacean plankton was only poorly represented, and Atlantic species were found including *Salpa fusiformis*, *Chelophyes appendiculata*, *Lensia conoidea*, *sulculeolaria* (= *Galettia biloba*), *Agalma elegans*, and the radiolarians *Thalassicolla* and *Collozoum*. *Cyanea*, *Aglantha*, and *Laodicea* were also present.

J. H. FRASER

B. Near Northern Seas

Plankton Investigations from Aberdeen

Phytoplankton

In January *Coscinodiscus* and *Thalassiothrix nitzschoides* extended from the Scottish coast to 0° E beyond which the dinoflagellates *Ceratium furca* and *C. macroceros* were dominant. *Halosphaera viridis* occurred from the Firth of Forth to Orkney.

In the spring *Skeletonema costatum* dominated the Scottish coastal waters with *T. nitzschoides* to the west and north. In all these areas high values of faecal pellets were observed. Small numbers of diatoms were found in April in the Norwegian Deeps but faecal pellets were abundant there with high numbers of *Calanus*. There was evidence in May of an inflow of mixed water into the North Sea from the north. *Rhizosolenia styliformis* was found at both sides of the northern North Sea with a patch of *R. alata* and *Globigerina* in the centre. *Halosphaera* was exceptionally abundant near Fair Isle.

By the summer the coastal phytoplankton had become much reduced with sparse patches of *Guinardia flaccida* and *Chaetoceros decipiens* in the Moray Firth and *C. decipiens* and *R. hebetata* further south. The rich zooplankton off the edge of the shelf off the west coast was associated with a high faecal pellet content amongst *R. alata*. In the central part of the northern North Sea *Ceratium macroceros* dominated the phytoplankton with *C. tripos* and the oceanic form *C. compressum* further north. Some evidence was seen of a leakage of mixed water from the north Scottish shelf through the Orkney passages with *R. alata*, *C. tripos*, and the medusa *Cosmetira*.

In late summer *C. debilis* was the dominant species in the Minch with *R. stouterfothii* off the east Scottish coast. *Halosphaera* was present both east and west of Scotland in October and November with the oceanic radiolarians *Thalassicolla* and *Collozum*.

T. LOVEGROVE

Zooplankton

Northern North Sea

The remnants of the autumn inflow of 1958 were still to be found in January 1959 east of Orkney and outside the Moray Firth where *Lensia fowleri*, *Pareuchaeta tonsa*, and *Sulculeolaria* were found, with mixed conditions spreading rather further into the North Sea area. *Sagitta setosa* was fairly general

south-east of a line from the Firth of Forth to Bergen, and other typical indigenous species such as *Tima bairdii* were also found. *Calanus* was found in moderate numbers only near the Scottish coast and over the Norwegian Deeps.

By March/April spring conditions were widespread with an abundant production of nauplii of *Calanus*, zoeas, and other decapod larvae associated with Scottish coastal waters. *Calanus* was common in the Shetland area near the Scottish coast, and over the Norwegian Deeps, but was still scarce in the central area. East of Shetland the plankton indicated an inflow of mixed water from the Faroe Channel with *Sagitta serratodentata*, *Agalma*, and *Arachnactis* larvae.

In May the samples showed *Calanus* to have increased in the mixed conditions. It was abundant with *Thysanoessa raschi* to the east but not to the north-east of Shetland where the conditions were more oceanic, and also at the edge of the Norwegian Deeps where *S. elegans* and larval fish were also most abundant. In the Fair Isle area the *Calanus* were associated with plutei and *Halosphaera*. *Oikopleura* was also common in 1959.

By midsummer there were signs of an inflow into the Moray Firth via the Orkney passages bringing with it *Agalma*, *Cosmetira*, and *Phialidium*, but this was not extensive and the main area was still predominantly a mixed community with a rich copepod population, and abundant planktonic larvae of lamellibranchs. *Sagitta setosa* was confined to the south-east of the area investigated.

Samples from August and September showed *Calanus* to be still abundant in the Fair Isle area but becoming reduced in Shetland. The small Orkney inflow still continued, bringing with it *Cosmetira* and *Euchaeta hebes*. *Oikopleura* was common in the Moray Firth.

During the last three months of the year *Calanus* became even further reduced and was found in only small numbers in the northern North Sea generally. There were however numbers of *Nyctiphanes couchii*, some *Clione* and echinoderm larvae. *Tima bairdii* was found north of the Dogger area with the siphonophore *Apolemia uvaria*. This siphonophore was first reported as a Lusitanian visitor to the North Sea (FRASER, Mar. Res. Scot. 1955) and it now seems to have become established. Its presence with *Tima* and *Sagitta setosa* in November 40 miles east of the Firth of Forth and 100 miles east of Aberdeen would not suggest that it was an oceanic visitor in 1959.

North and West Scotland

Plankton collections in March west of Scotland showed *Calanus* to be abundant in the shelf water and Minch but oceanic species were found outside, including *Eudoxoides spiralis*, *Chelophyes*, *Agalma*, *Tomopteris nisseni*, *Arachnactes* larvae, and some of the oceanic fauna continued along the edge of the deep water, overflowing on to the shelf and reaching Orkney.

By May and June an intense core of Lusitanian species mixed with Atlantic species was found entering the Faroe Channel south of 60°30'N. This included a first record for the area of the heteropod *Pterotrachea scutata*, supported by a host of other interesting exotics such as *Phronima crassipes*, *Nectopyramis spinosa*, *N. diomedea*, *Rosacea cymbiformis*, *R. plicata*, *Chuniphyes multidentata*, *Lensia fowleri*, *Vanadis crystallina*, *Clio polita*. Only the fringe of the core reached Shetland so that the northern North Sea contained a very mixed fauna.

Between this core and the shelf was a band of *Calanus*, which extended along the shelf off the west of Scotland to Orkney and was again found to the north of Shetland. *Doliioletta gegenbauri* was very abundant beyond the edge of the shelf west of the Hebrides. They did not penetrate into the Faroe Channel until July, and again the main oceanic fauna was concentrated south of 60°30'N and only a mixed community was found at Shetland.

Sampling in October confirmed a similar situation, the core of Lusitanian and Atlantic species being still present with *Velella*, *Vogtia spinosa*, *Agalma elegans*, *Solmaris corona*, *Pantachogon rubrum*, *Arachnactes*, *Thalassicolla*, and larval *Fierasfer*. Although some of this oceanic core reached Shetland (e. g. *Lensia fowleri*, *Hippopodius*, *Thalassicolla* etc.) only mixed fauna was found to have penetrated into the North Sea.

Plankton conditions in 1959 in the northern North Sea thus indicate a good mixed community early in the year leading to a good production of copepods and good feeding for herring. There was a strong inflow of oceanic forms into the Faroe Channel continuing at least until October, but only a mixed community continued into the North Sea via the north of Shetland. A small inflow through the Orkney passages in summer did not penetrate very far.

J. H. FRASER

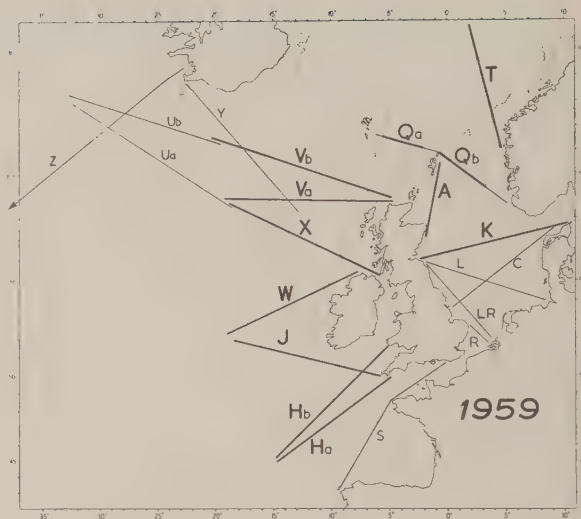


Figure 7. A chart showing the routes along which the Continuous Plankton Recorder was towed during 1959. Routes used for the histograms in the figures which follow are indicated by a thick line; in the figures and in the text they are referred to their code letters, H, J, W, X, V, Qa, T, Qb, A, and K.

The Continuous Plankton Recorder Survey: Plankton around the British Isles during 1959

(Figures 7-15)

The Continuous Plankton Recorder was used, at the standard depth of 10 metres and at monthly intervals, on the routes shown in Figure 7. The survey was similar to that of previous years but the Z route was extended to sample from Iceland to the Newfoundland Banks. This route, which links the ICES and ICNAF areas, is operated with the assistance of the Fisheries Laboratory of the University Research Institute at Reykjavik. The R route (Hull-Rotterdam) was replaced, during the year, by LR running from Leith to Rotterdam.

Brief summaries of the results obtained during each year of the survey have been published in the Annales Biologiques. The present summary, like its predecessors, is based on a selection of routes spread around the British Isles. Information about the plankton collected on the other routes, and further details concerning the routes shown here, will be supplied on application to the Officer-in-Charge, Oceanographic Laboratory, 78 Craighall Road, Edinburgh 6, Scotland.

As before, results from routes Ha, Hb, and J are combined, as also are the Va and Vb records. The Q route is divided into Qa (between the continental shelf and the Faroes) and Qb (sampling over the

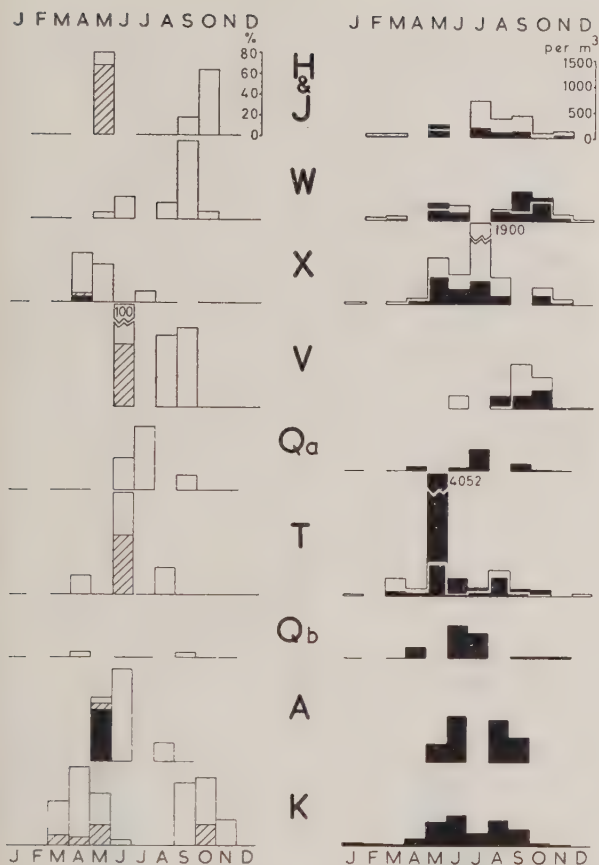


Figure 8 (left). A month-by-month estimate of the quantity of phytoplankton on the Recorder routes shown by a thick line in Figure 7. The open part of the histogram shows the percentage of the filtering silk which was coloured "pale green", the hatched part coloured "green", and the blacked in part "dark green"; estimated by comparison with an arbitrary colour scale. A gap in the base line indicates that there were no samples in that month. Only that part of the record taken over deep water, outside the 100 fathom contour, has been included on routes H, J, W, X, V, Qa, and T. The whole of routes A and K have been used but only that part of Qb which sampled the shallow North Sea plateau.

Figure 9 (right). Histograms showing, month-by-month, the numbers of Total Copepoda (all species combined) taken on the Recorder routes shown by a thick line in Figure 7. The histograms represent the number of copepods per cubic metre of water sampled along the whole length of tow on routes A and K, along the deep Atlantic part of route Qa and the North Sea plateau part of Qb. The two parts of the tows which lay on either side of the 100 fathom contour on routes H, J, W, X, V, and T have been separated, the solid histogram showing the numbers over the deep water and the open histogram over the shallow water of the continental shelf. A gap in the base line indicates that there were no samples in that month.

North Sea plateau). In addition to the standard routes, shown by thick or thin lines in Figure 7, extra samples were collected from R.V. "Sarsia" (Marine Biological Association, Plymouth) and R.V. "Sir William Hardy" (Department of Scientific and Industrial Research, Aberdeen).

The histograms in Figure 8 provide a measure of the abundance of phytoplankton based on the green colouration of the filtering silk. As in previous years, the spring flowering occurred earlier in the North Sea than in the Atlantic (March on the K route, compared with April or May on the Atlantic routes).

In the North Sea, the spring outburst began rather earlier than usual and, at first, the numbers

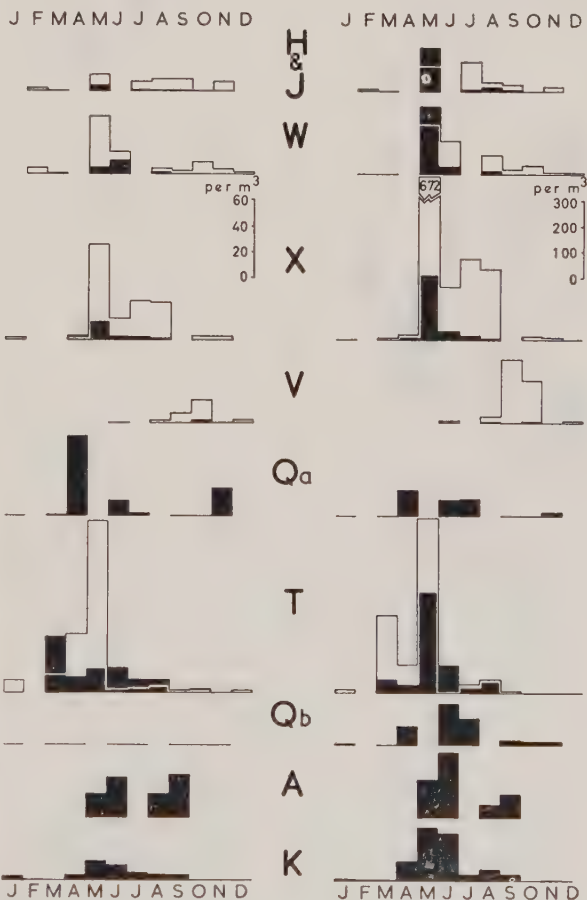


Figure 10 (left). Histograms showing, month-by-month, the numbers of large *Calanus finmarchicus* (copepodid stages V and VI) taken on the Recorder routes shown by a thick line in Figure 7. Details as in Figure 9.

Figure 11 (right). Histograms showing, month-by-month, the numbers of *Calanus finmarchicus* (all stages combined) taken on the Recorder routes shown by a thick line in Figure 7. Details as in Figure 9.

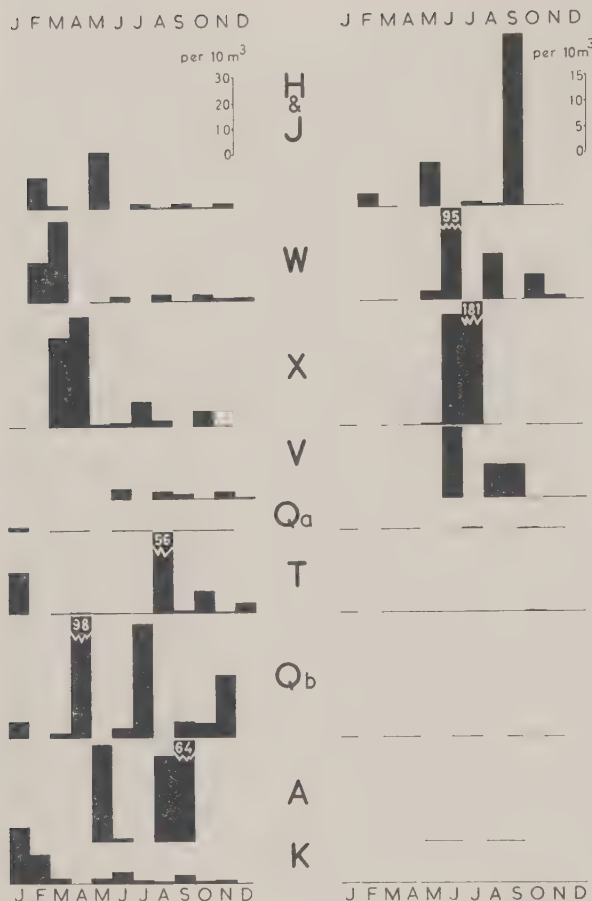
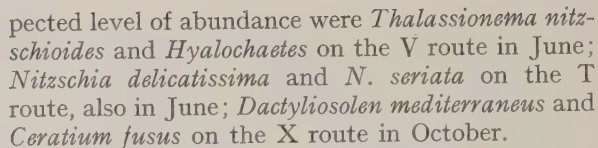


Figure 12 (left). Histograms showing, month-by-month, the numbers of *Meridia lucens* taken on the Recorder routes shown by a thick line in Figure 7. The histograms represent the number of organisms per ten cubic metres of water sampled along the whole length of routes A and K and the North Sea plateau part of Qb. Only that part of the record taken over deep water, outside the 100 fathom contour, has been used from routes H, J, W, X, V, Qa, and T. A gap in the base line indicates that there were no samples in that month.



There was some recovery of the numbers of copepods (Figure 9) which had been relatively low in 1958. The species balance within the copepods in 1959 was the reverse of that in 1958 when small species were relatively rare and *Calanus* was abundant. In 1959 there were unusually large numbers of such copepods as *Temora longicornis*, *Pseudocalanus elongatus*, and *Acartia clausi* but *Calanus*, after a normal start in the spring, became most scarce for the rest of the year; this was particularly noticeable in the North Sea (Figures 10 and 11). The reduction

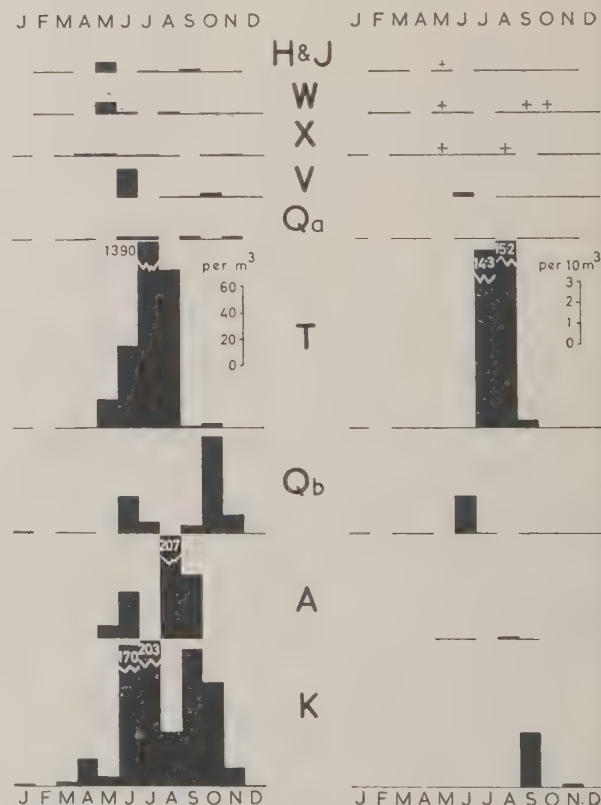


Figure 13 (right). Histograms showing, month-by-month, the numbers of *Thalassia* taken on Recorder routes shown by a thick line in Figure 7. Details as in Figure 12. of diatoms were higher than in 1958. Subsequently there was a sharp decline, and both diatoms and dinoflagellates were less numerous than usual throughout the summer and autumn; only *Ceratium macroceros*, in October, was abundant and diatoms were very scarce.

In the Atlantic most of the phytoplankton species were less abundant than in 1958, and as in the North Sea, this was most marked in the summer and autumn. Species which appeared at about the ex-

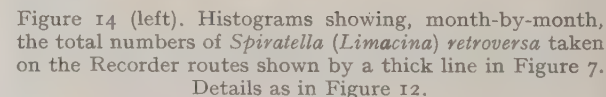


Figure 14 (left). Histograms showing, month-by-month, the total numbers of *Spivatella* (*Limacina*) *retroversa* taken on the Recorder routes shown by a thick line in Figure 7. Details as in Figure 12.

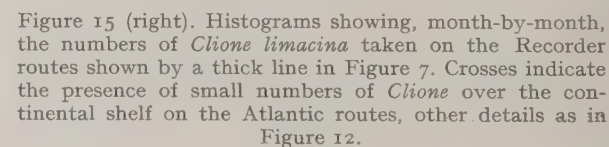


Figure 15 (right). Histograms showing, month-by-month, the numbers of *Clione limacina* taken on the Recorder routes shown by a thick line in Figure 7. Crosses indicate the presence of small numbers of *Clione* over the continental shelf on the Atlantic routes, other details as in Figure 12.

in numbers of *Calanus* was more marked in the large stages (V and VI) than in the young copepodites. The results of the Hardy Plankton Indicator survey of the Scottish east coast herring grounds confirmed this scarcity of *Calanus*; between June and September, the average abundance of *Calanus* was lower than the comparable figure in any year since the survey was started in 1947.

Metridia lucens (Figure 12) was present in moderate numbers, slightly less abundant than in 1958 but only a small fraction of the numbers found in 1950 to 1953. In the North Sea in 1958, *Metridia* was scarce until the last three months of the year; some evidence of the persistence of this overwintering population can be seen in Figure 12 (K route January to March). Numbers were higher than usual on the Qb and A routes in April and May suggesting the possibility of a minor inflow of Atlantic coastal waters in those months, and perhaps again in July and August; there is some evidence from the diatoms in support of this suggestion of coastal inflow.

The distribution of Thaliacea is shown in Figure 13. As with the copepods, the results were strikingly different from those obtained in 1958 when *Salpa fusiformis*, in fairly large numbers, penetrated into the Norwegian Sea and the North Sea (T, Qb, and A routes). In 1959 there was no sign of this invasion and, in further contrast to 1958, no specimens of *Salpa* were found in the Faroe-Shetland Channel. On the other hand, doliolid species (which were scarce or absent in 1958) were plentiful in 1959. In May, *D. gegenbauri* was found on routes H and J; thereafter it travelled northwards, on the W route in June, off the Hebridean Shelf in June and July, and in the Faroe-Shetland Channel in early July. These populations of *Dolioletta* were found in their expected positions, between the western banks and the 100 fathom contour. *Thalia democratica* was found on the J route in September, and off the western entrance to the English Channel and west of Ireland in October. *Ihleia asymmetrica* occurred on the V route in September, and *Iasis zonaria* to the west of Scotland (X route) in November.

Because of a change in the methods of routine analysis of the Recorder silks, it is impossible to provide histograms for large specimens of *Spiratella* (*Limacina*) *retroversa*. Instead, the total numbers of *Spiratella* have been used to construct Figure 14 which, like the figures for this species in previous years, shows the numbers over the oceanic parts only of the Atlantic records. The numbers appeared to be rather below average in 1959, most markedly so over the deep Atlantic. There is some evidence from Recorder sampling that *Spiratella*, like *Clione*

limacina, has undergone an appreciable change in its distribution pattern during the last ten years. Prior to 1953 both these species were more abundant over the deep parts of the Atlantic routes than they were over the continental shelf. Since 1953 their distributions have shifted progressively eastwards and, since 1956, they have been abundant over the shallow waters of the shelf but relatively scarce over the deep oceanic waters. This change may offer a partial explanation for the increased abundance of these species in the North Sea since 1953. The large numbers of *Spiratella* on the T, A, and K routes may be evidence of continuity with the populations in the coastal waters of the Atlantic.

Clione limacina (Figure 15) was less abundant than in 1958, and markedly less so than in the period 1951–1954. It was absent over the deep parts of the Atlantic records but occurred in small or moderate numbers over the continental shelf. It was moderately abundant in July and August in the Norwegian Sea (T route). These, however, were the large forms, possibly with an Arctic origin; they form a population quite distinct from the very small southern forms which occurred on the other Recorder routes.

The main impressions gained from the plankton in 1959 are twofold; firstly the change in the early summer, involving a sharp decrease in the abundance of phytoplankton and *Calanus*; secondly the big difference between 1959 and 1958. In the survey of the Scottish summer herring fishery the difference between the two years was the greatest between any two successive years since the survey began in 1947. Using an objective standard of "abundance", it was found that all the forms which were "abundant" in 1958 were "scarce" in 1959 and vice versa. The average abundance of nine out of sixteen species was either greater or less than we have ever known on the Buchan fishing grounds; for example, the average number of *Temora longicornis* per Plankton Indicator sample was 254, compared with a range of 4 to 40 per sample in the preceding six years. A striking feature was the return to abundance, in 1959, of *Pseudocalanus*, *Temora longicornis*, *Acartia clausi*, *Centropages hamatus*, *Evadne* sp., *Podon* sp., and *Oikopleura* sp. All these forms had been relatively rare (in the north-western North Sea) since 1952; it may be significant that all of these species returned to abundance in the same year after they had all been relatively scarce for so long.

In general the material suggests that in 1959 there was a return to the plankton conditions found prior to 1952 and that the year was probably most like 1949. There were very few signs of an oceanic

invasion of the North Sea but there was a strong suggestion of an intrusion of Atlantic coastal water into the North Sea, possibly partly through the Orkney-Shetland passage. This minor inflow may have occurred in early and late summer. For example, in September *Euchaeta hebes* and *Rhincalanus nasutus* were found between the Moray Firth and Shetland. In the same month and further south, off the Firth of Forth, there was a mixture of *Tomopteris* spp., *Clione*, *Eucalanus crassus*, *Candacia armata*, *Sagitta elegans*, *Centropages typicus*, *Dactylosolen mediterraneus*, and *Ceratium lineatum*; suggesting the presence in the North Sea of Atlantic coastal water.

R. S. GLOVER and BEATRICE I. BARNES

Investigations of the Bottom Fauna in the Eastern Part of the German Bight, 1959

(Figures 16-17; Tables 6-7)

The quantitative and qualitative bottom fauna investigations in the eastern part of the German Bight have been continued in 1959. The R/V "Uthörn", using a $\frac{1}{10}$ m² van Veen grab, collected at the 21 routine stations 42 bottom samples during the spring cruise, and 43 during the autumn cruise.

The most important results of the 1959 investigations are: (a) the high total biomass in autumn, only a little below the highest value ascertained since 1949, viz. in the autumn of 1957 (see Ann. Biol., 15: 62); (b) an increase in the lamellibranchs; and (c) a decline in the stocks of polychaetes (Table 6).

Whereas the greater part of the living organisms per $\frac{1}{10}$ m² consisted of polychaetes in the autumn of 1957, viz. about 50%, the lamellibranchs formed 65% of the stock in the autumn of 1959.

Unusually high numbers could be observed of *Angulus fabula*, the lamellibranch species most frequently eaten by plaice in the area of investigation; 42.4% of the lamellibranchs from the grab samples belonged to the species *Angulus fabula*.

Table 6.

	1957		1958		1959	
	Spr.	Aut.	Spr.	Aut.	Spr.	Aut.
Average numbers in 0.10 m ² at all stations						
Lamellibranchs .	34.6	74.9	53.5	52.8	38.0	69.9
<i>Lunatia nitida</i> .	0.1	0.2	0.2	0.5	0.4	0.8
Polychaetes . .	45.4	195.7	58.6	90.3	27.8	67.9
Crustaceans . .	9.9	25.4	15.2	26.7	11.7	11.7
Echinoderms . .	6.2	16.2	4.4	22.7	7.3	13.7
of which						
<i>E. cordatum</i> .	0.4	6.1	1.3	13.3	1.3	5.0
Average total stock in 0.10 m ² (biomass in cm ³)						
<i>E. cordatum</i> excepted . . .	4.8	8.1	4.9	4.8	3.9	7.7
Average stock in 0.10 m ² (biomass in cm ³)						
Lamellibranchs .	2.2	3.2	2.6	2.6	2.3	5.0
Polychaetes . .	2.1	4.1	1.8	1.5	1.3	1.9

Table 7 demonstrates how the considerable increase of the *Angulus fabula* stock led to a greater number of grab samples containing over 50 *Angulus fabula* per $\frac{1}{10}$ m². Three of the ten grab samples collected in the autumn of 1959 contained even over 100 *Angulus fabula*, with a maximum of 166 specimens, per $\frac{1}{10}$ m².

Only one-third of the *Angulus fabula* taken out of the grab samples in the autumn of 1959 consisted of juvenile animals, with a shell length under 5 mm. The corresponding values for autumn 1958 and autumn 1957 are 52% and 41% respectively. If one compares these values with the temperature observations in the respective years (Fig. 16), without taking into consideration the losses brought about by enemies and other natural causes, one can conclude that very probably mild winters, and an early rise of the water temperature in late winter and early spring, will have a favourable effect on the growth of the juvenile specimens, especially in dense stocks; this presumably because of an early resumption of feeding activities.

The following other lamellibranch species contributed to the high biomass and abundance figures

Table 7.

	1949		1950		1951		1952		1953		1954		1955		1956		1957		1958		1959	
	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	
Number of bottom samples (0.10 m ²)	13	20	34	36	37	42	42	42	45	58	44	31	45	63	43	42	45	42	42	42	43	
Number of samples with over 50 <i>Angulus fabula</i>	—	—	1	4	2	—	2	2	5	3	1	1	5	2	—	—	4	3	7	4	10	

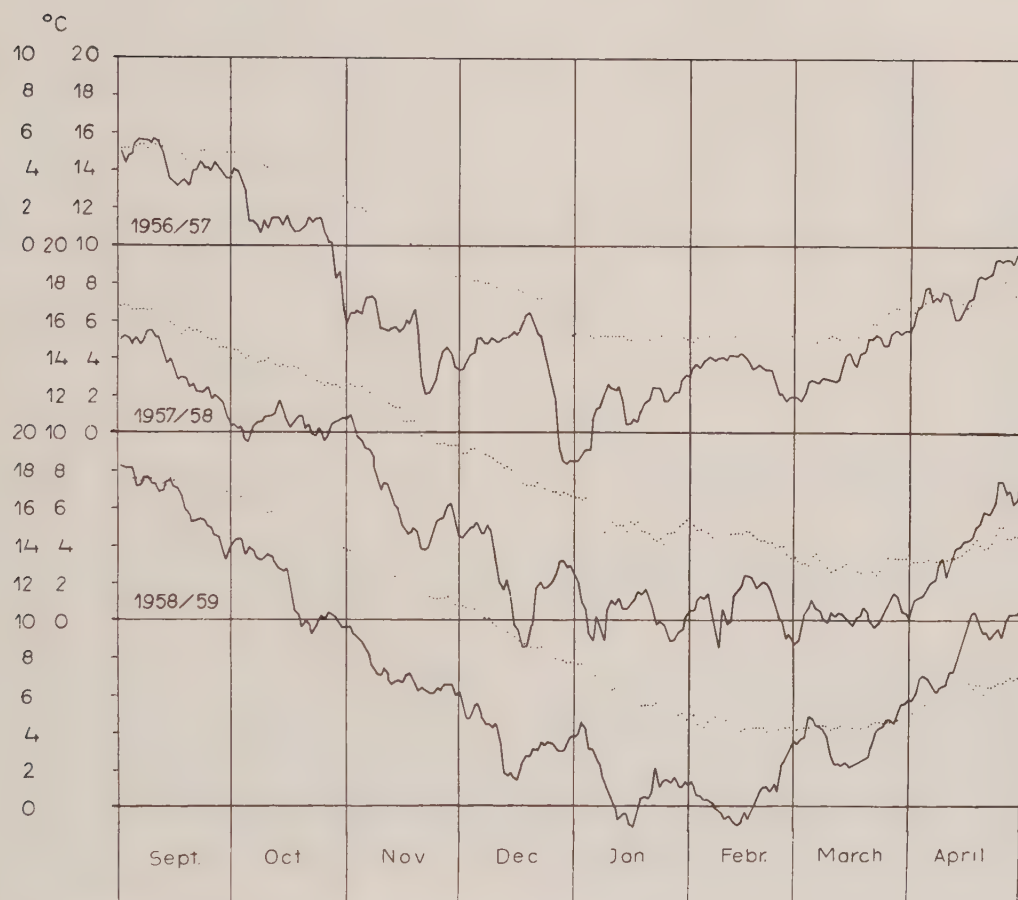


Figure 16. Surface water temperatures in the Waddensea near List/Sylt (whole line) and surface temperatures near the lightvessel «P₈» (dotted line).

in the autumn of 1959: *Nucula nitida* (with an average stock number of 16.5 specimens per $\frac{1}{10}$ m²), *Abra alba* (6.4), and *Montacuta bidentata* (5.1). The figures for the other lamellibranch species remain within the range of the numbers ascertained in the preceding years, be it with lesser or larger fluctuations. Noteworthy for the spring of 1959 is the rare observation of a few densely settled patches of *Venus gallina* (up to 75 specimens per $\frac{1}{10}$ m²) in muddy sand at 2 stations near the Danish coast off Esbjerg at 14 and 20 m depth, respectively. A remarkable increase in the numbers of *Lunatia nitida* was observed in 1958, parallel with the general increase in the number of lamellibranchs since 1957 (see Ann. Biol., 15 : 62). Abundance and spreading of this predatory snail, which feeds

almost exclusively on living lamellibranchs, depends largely on the quantities of lamellibranchs available (Fig. 17). The sieve residue of the grab samples in spring and autumn 1959 contained more fresh lamellibranch shells showing newly drilled *Lunatia* holes than in the preceding years.

The numbers of polychaetes were in spring and autumn of 1959 for the first time lower than those of the lamellibranchs. The three more numerous species: *Nephtys hombergi*, *Spiophanes bombyx*, and *Magelona papillicornis* formed in the spring of 1959 one-quarter, and in autumn one-third of the stock numbers. In autumn 1959 other numerous polychaetes were: *Lanice conchilega* (9.3%), and *Pectinaria koreni* (7.7%).

The 1959 investigations confirm the constant

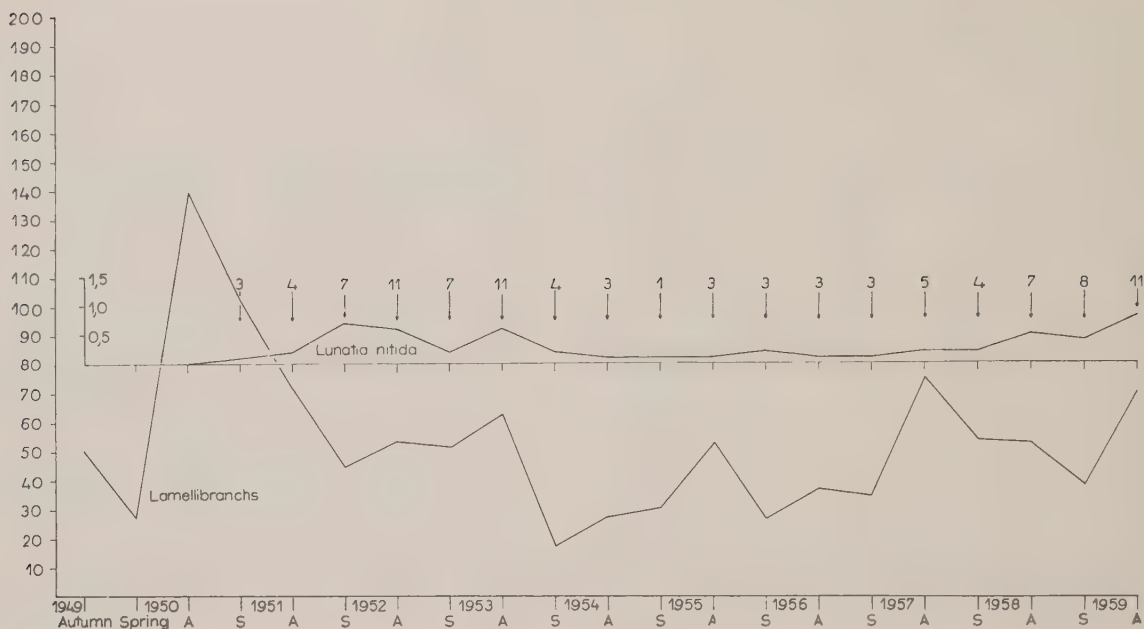


Figure 17. Quantities of lamellibranchs available. The figures over the upper curve give the number of stations where *Lunatia nitida* was caught each year by means of the bottom grab.

level of abundance of the Crustacea as a whole, as has repeatedly been mentioned in the notes of the preceding years. Considerable seasonal and annual fluctuations have, however, been noticed in several amphipode species. In the spring of 1959, *Bathyporeia guilliamsoniana*, with 66% of the average stock number per $\frac{1}{10} \text{ m}^2$, was the most frequent amphipod species. In autumn, *Urothoe poseidonis*

and the Cumacea *Diastylis rathkei* prey on this species.

In the abundance of the echinoderms, only insignificant changes were recorded in comparison with 1958, with exception of the diminution of the stock of *Echinocardium cordatum*. The stock numbers of *Amphiura filiformis* corresponded to those observed in the preceding year.

E. ZIEGELMEIER

C. Baltic-Belt Seas

Polish Macroplankton Observations in 1959

The macroplankton of the southern Baltic has undergone considerable changes. At the beginning of the year all the species brought in there by incursion of salt water from west in the autumn of 1958 were still to be found. The species were *Sagitta setosa* and *Calanus finmarchicus*. During the following months these species could not be traced in the Baltic plankton but they appeared again in the autumn of 1959. Apart from *Calanus* and *Sagitta*, *Oikopleura dioica* was also encountered and, for the first time, *Tomopteris*. The specimen collected was young and therefore the species was not determined. It appeared in the plankton collected in the eastern part of Arkona Deep. The changes mentioned above were most prominent in Arkona Deep and in Bornholm Deep; no changes occurred in Gdansk Deep.

It is a striking fact that *Sagitta elegans baltica* appeared in very small numbers in the southern Baltic. The greatest number of adult individuals in Bornholm Deep amounted to 109 specimens per 1 m² of sea surface; this species did not at all appear in Gdansk Deep. From this fact there is evidence for concluding that the salinity conditions and, very likely, the situation of the oxygen content are being aggravated.

The scanty observations carried out in the spring (March/April) of 1959 point to the fact that spawning of the cod, estimated by the amount of eggs per m² of sea surface, may be presumed to be rather poor.

On the other hand, the spawning of sprat was favourable.

W. MAŃKOWSKI

Sphaerodorum balticum Reimers in the Southern Baltic

(Figure 18)

The polychaete *Sphaerodorum balticum* Reimers 1933, belonging to the order *Nereimorpha*, has according to our knowledge only been known to occur in the Kiel Bay.

This tiny species averaging scarcely 2 mm in length, was discovered by REMANE and its morphology and anatomy has subsequently been investigated by REIMERS (1933).

The observations concerning the geographic and bathymetric distribution of this species has shown that it is distinctly stenotypic, occurring in greyish-yellowish clay deposits stretching as a narrow belt

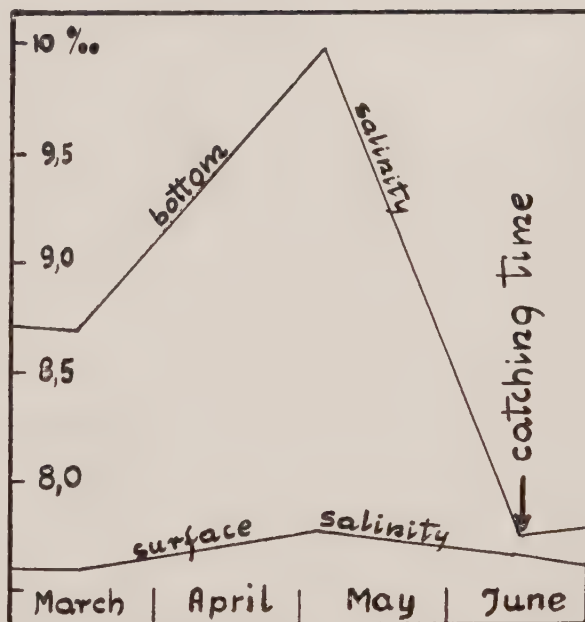


Figure 18. Salinity variation at the station in position 55°14'N, 16°30'E.

in the boundary between sand and mud inside the coastal zone at a depth of 6 to 8 m. It occurs there in communities comprising among others the Foraminifera sea-anemone: *Halcanpa duodecimcirrata*; Polychaeta; *Harmothoe umbricata*, *Terebellides strömi*, *Nephtys ciliata*; Crustacea as *Microdeutopus gryllotalpa*; Mollusca: *Corbula gibba*, *Macoma baltica*, *Cardium fasciatum*, and *Hydrobia ulvae*.

In spite of the fact that the *Sphaerodorum* had so far only been found in the Kiel Bay, REIMERS assumed that it occurred in a wide area of the south-western Baltic. It should, however, be kept in mind that at the time when REIMERS described this species, Lübeck Bay, Kiel Bay, and the entire Belt Sea was considered belonging to the Baltic, and REIMERS therefore named this species *Sphaerodorum balticum*. Other species of this genus are typical inhabitants of temperate and cold seas of both hemispheres at depths from the surface to 3,400 metres. They also occur among plankton and benthos species originating from different regions of the North Atlantic, including arctic and antarctic waters. However, no indication of occurrence of any specimen of the genus *Sphaerodorum* has been recorded neither from brackish waters nor from the Baltic proper (beyond the ridge Gedser/Dars). It is therefore noteworthy that on 16. June 1956 the

Table 8. Average values of numerical strength and biomass of zooplankton (Copepoda) of the central Baltic for the period 1949/1959 (by months)

Months	Number per 1 m ³				Biomass in mg/m ³				Number of years of observations		
	0-50 m		50-100 m		0-50 m		50-100 m				
	1959	1949-59	1959	1949-59	1959	1949-59	1959	1949-59			
January	—	(3,530)	—	(3,020)	—	(82)	—	(70)	—	(76)	1
February	1,620	1,890	550	920	60	72	25	42	43	57	4
March	2,070	2,200	890	890	61	56	52	51	57	54	2
April	6,160	2,950	1,300	660	48	54	73	56	61	55	4
May	13,750	10,390	2,040	3,270	121	69	63	52	92	60	7
June	(10,260)	14,250	(2,880)	3,360	(189)	197	(119)	70	(154)	134	6
July	(11,740)	11,180	(3,860)	2,850	(230)	217	(147)	118	(188)	168	6
August	(22,120)	11,680	(3,100)	4,360	(290)	240	(92)	151	(191)	196	6
September	—	9,880	—	3,540	—	196	—	140	168	168	4
October	12,820	6,500	4,300	3,470	143	125	108	130	125	126	6
November	—	(6,630)	—	(5,000)	—	(106)	—	(115)	—	(110)	2
December	—	5,080	—	(3,020)	—	(95)	—	(93)	—	(94)	2
Average	10,070	7,180	2,365	2,860	143	126	85	91	114	108	—

Sphaerodorum balticum was caught by biologists from the Sea Fisheries Institute of Gdynia; the position of capture was in the southern Baltic, precisely over the ridge between Bornholm Deep and the Slupsk Furrow (55°14'N, 16°30'E). The temperature of the water at the station on that particular day amounted to 11.3° C at the surface and 1.5° C near the bottom, the salinity being in the region of 7.8‰ in the whole water column (Fig. 18).

The *Sphaerodorum balticum* specimens were caught between 1400 and 1500 GMT by means of a Nansen net in a vertical haul from the clayey and stony bottom (55.5 m) to the surface.

According to REIMERS, *Sphaerodorum balticum*, contrary to other benthonic-pelagic species, live exclusively on the bottom. He based this statement on his own observations on aquarium cultures of animals which crept over the bottom with the aid of parapodia and, in a less degree, by waving

motions of their bodies. Our samples, though collected with the plankton net cannot serve as a proof that *Sphaerodorum balticum* possess the ability of swimming, because among the specimens discussed above such exclusively benthonic species as *Macoma baltica* L. occurred there, together with very distinct planctonic species.

K. SIUDZINSKI
L. ZMUDZINSKI

Quantitative Estimation of Plankton in the Central Baltic and the Gulf of Riga in 1959

(Figures 19-21; Tables 8-9)

Quantitative estimation of plankton in the central Baltic was based on the results of investigations at 12 standard oceanographic stations occupied in accordance with the IGY programme of research, and on the data obtained from 10-12 standard stations in the Gulf of Riga, worked for years by the Institute of Fisheries of the Latvian SSR (the

Table 9. Average values of numerical strength and biomass of Plankton (Copepoda) of the Gulf of Riga for the period 1949/1959 (by months)

Months	Number per 1 m ³				Biomass mg/m ³				Number of years of observations
	0-20 m		20-40 m		0-20 m		20-40 m		
	1959	1949-59	1959	1949-59	1959	1949-59	1959	1949-59	
January	—	3,820	—	(1,380) ¹⁾	—	32	—	(31)	2
February	3,360	3,190	1,010	1,060	52	49	20	20	3
March	3,300	3,240	940	990	46	43	21	22	2
April	15,320	11,760	2,390	1,770	71	60	23	16	4
May	35,350	10,600	4,780	2,660	362	156	187	110	9
June	16,840	11,660	2,970	2,690	447	218	206	147	7
July	16,000	19,990	2,440	6,890	193	273	153	254	8
August	19,740	22,870	3,370	6,150	220	337	344	271	6
September	(38,820)	22,840	(19,910)	14,480	(390)	292	(332)	390	6
October	22,140	15,010	13,530	5,580	197	176	191	134	7
November	10,050	4,280	5,420	2,600	182	85	95	60	6
December	4,620	3,420	3,920	(3,710)	61	—	67	—	2
Average	16,870	11,060	5,520	4,200	202	156	149	132	—

¹⁾ Data in brackets are based on small number of observations.

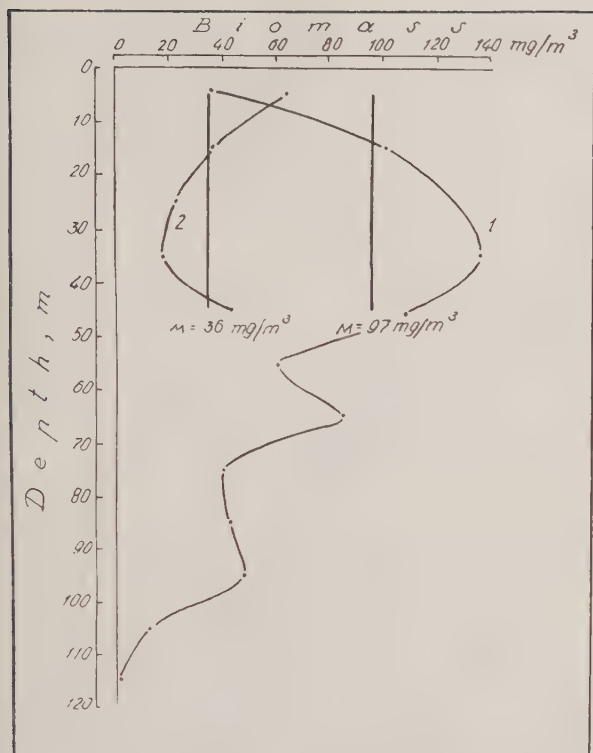


Figure 19. Vertical distribution of zooplankton biomass in February 1959 in Gothland Deep (1) and Gulf of Riga (2) and the mean values (M) for the 0-50 m layer.

former Latvian Branch of VNIRO). As in the past, plankton was sampled with No. 38 (38 threads per cm) Juday net of 37 cm diameter (0.1 m²). The precipitation method was used for measuring micro-zooplankton and phytoplankton sampled with the Nansen bottle.

A summary of the quantitative results and the mean values for the period 1949/59 is shown in Tables 8 and 9.

The specific composition of phyto- and zooplankton samples appeared to be normal. As in the previous two or three years, the typical salt-water species *Sagitta elegans baltica* and *Oithona similis* were absent in the area E of Bornholm Deep, a fact which serves as a good index of the lower salinity in the deeps. In February great concentrations of medusae (mainly *Aurelia aurita*) were observed in the Gothland Deep at 70/90 m depth.

The middle and upper layers were relatively abundant with *Fritillaria borealis* and *Pleurobrachia pileus*. The latter species sometimes caused the water to glow during night hauls with the plankton net.

The numerical strength and biomass of crustaceans (Copepoda and Cladocera) in winter (Febru-

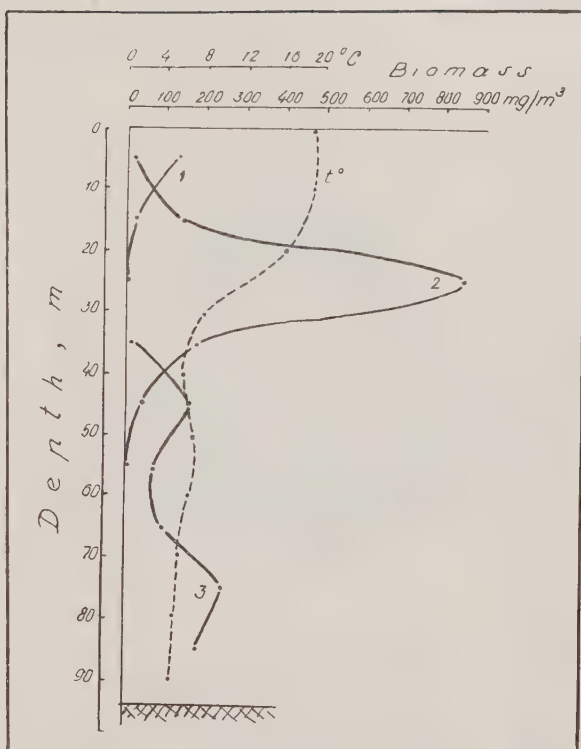


Figure 20. Vertical distribution of zooplankton biomass in Bornholm Deep on 26. July 1959.

- 1 = *Bosmina coregoni* var. *maritima*
2 = *Temora* + *Centropages* + *Acartia*
3 = *Pseudocalanus elongatus*

ary) was somewhat below average. This presumably is explained by a more intensive feeding of fish on zooplankton than in previous years, due to a relatively higher temperature of the water. On the other hand, the production of phytoplankton was lower owing to prevailing cloudy and stormy weather.

The spring development of plankton was unusually high and the quantitative values of zooplankton in May were above the long-term average both in the Baltic proper and the Gulf of Riga. Rapid development in spring was characteristic for all principal species of copepods (*Pseudocalanus elongatus*, *Temora longicornis*, and *Acartia longiremis* in the Baltic and *Eurytemora hirundoides* and *Acartia biflosa* in the Gulf of Riga). The very intensive development of zooplankton in spring was increased by a stormy growth of phytoplankton caused by a great river discharge during winter. The amount of water discharged from the Western Dvina (Daugava) river from January to March constituted 200% of the long-term average value. The development of plankton was also advanced by the high temperatures of the water and the favourable light

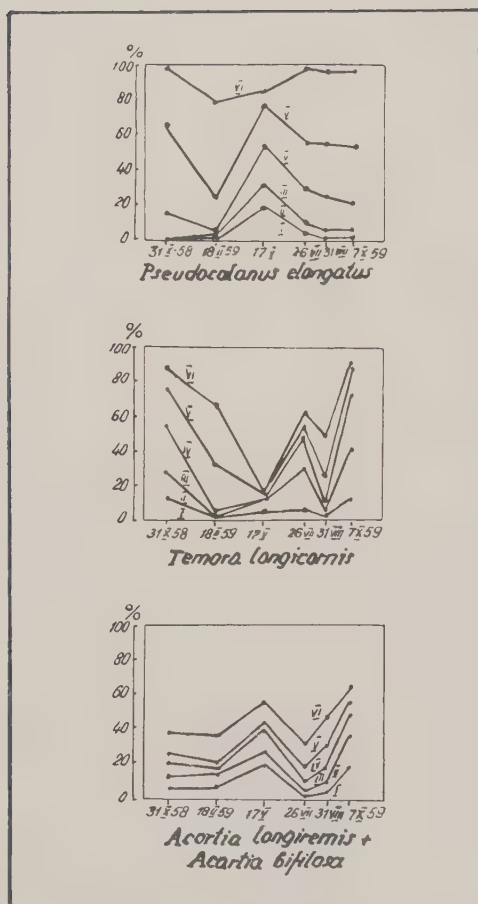


Figure 21. Age composition of the population of the main species of Copepoda in the central Baltic according to the relative abundance of the copepodite stages (I–VI) in the period 31. October 1958 to 7. October 1959 (based on material collected with plankton net).

conditions; the number of sunny days in Liepaja during March/May amounted to 173% of the long-term mean.

In summer a strong heating of the upper water layers caused a very intensive development of Cladocera (especially *Bosmina coregoni* v. *maritima*). At the same time the growth of Copepoda, particularly in the middle and deep layers, proceeded on a more moderate scale. Feeding conditions of plankton-eating fish and larvae in the upper water layers can be considered favourable in 1959. The second outburst in the production of Copepoda (*Temora*, *Acartia*, and *Eurytemora*) was observed in autumn and resulted in higher numerical and biomass values in October.

The vertical distribution of zooplankton in the central Gothland Deep (station No. 8) was confined

throughout the year to the depth of 110–120 m due to deficiency in oxygen (content of O_2 at 120 m did not exceed 10% and equalled zero at 150 m).

Once again the regularity in the regional distribution of plankton, observed earlier, was confirmed: the amount of zooplankton biomass is higher in winter in the central Baltic, but lower in summer, than in the Gulf of Riga.

At many stations the water column was surveyed at 10 m intervals as a means of establishing the characteristic stratification of the zooplankton. Examples of such stratification are shown in Figures 19 and 20.

The age composition of the populations of the main Copepoda species is shown in Figure 21.

I. I. NIKOLAEV and N. K. KRIEVS

Characteristic Features of the Bottom Fauna in the Eastern Baltic in 1959

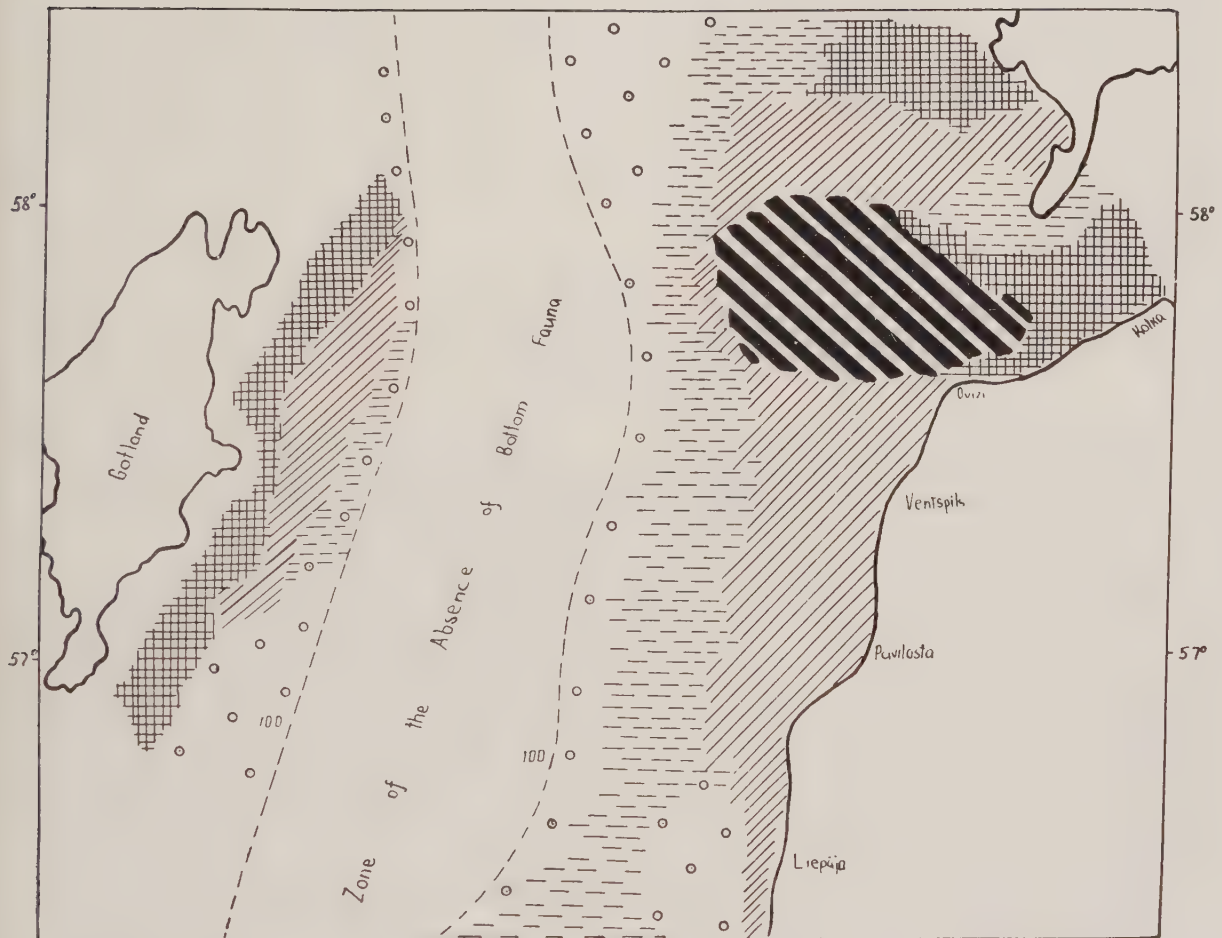
(Figure 22; Table 10)

In 1959 the Latvian Research Institute of Fisheries collected material on the qualitative characteristics of the distribution of the benthos biomass at 30 stations in the eastern Baltic from 56°N to 58°15'N. As in previous years samples were taken with the Petersen grab (0.1 m²) and washed on metal sieves of 0.1–0.12 mm mesh.

In the Baltic, relatively rapid changes are observed from periods of high salinity to freshening periods resulting, on the one hand, from the influence of oceanic waters from the North Sea and, on the other hand, from fresh waters discharged from the rivers.

In the period 1936 to 1953/54 a gradual increase in the salt content was observed as a result of an active inflow of water masses from the North Sea. The deeps were filled with well aerated water with salinity values reaching 13.69‰ at 200 m depth (SOSKIN, 1956). This period is remarkable for the expansion of the ecological habitats of boreal-Arctic complexes of benthic fauna.

The period from 1955 to 1959 is, on the other hand, characterized by an intensified river discharge and a reduced inflow of North Sea waters followed, in its turn, by a deterioration of the gaseous, saline, and thermal conditions of the sea. Especially affected were the waters in the deeps, particularly the Gothland Deep, which is farthest removed from the Kattegat and Skagerak. Studies carried out in 1956/59 have shown that decrease in the bottom fauna was caused by oxygen deficiency (0.04 to 0.24 ml/l) and the appearance, at depths from 80 to 90 m to 240 m, of hydrogen sulphide in the area



Quantitative Distribution of Bottom Fauna 1959 (Eastern Baltic)



Figure 22. Showing the dead zone in the Baltic.

Table 10. Numerical strength and biomass of some species of the bottom fauna in the eastern Baltic in 1959

Depth in m	21-30		31-40		41-50		51-60		61-70		71-80		81-90	
Species	N	g/m ²	N	g/m ²	N	g/m ²	N	g/m ²	N	g/m ²	N	g/m ²	N	g/m ²
<i>Macoma baltica</i> (L.)	130	73.42	96	38.39	19	12.6	82	53.1	5	2.43	7	4.58	—	—
<i>Pontoporeia affinis</i>														
Lindström	67	0.4	706	1.64	141	0.44	300	1.08	10	0.05	—	—	—	—
<i>Pontoporeia femorata</i>														
Krøyer	—	—	6	0.05	—	—	585	4.22	585	4.75	593	4.63	—	—
<i>Mesidothea entomon</i>														
(L.)	5	2.75	6	1.42	11	0.9	45	4.85	2	6.7	16	0.39	—	—
<i>Harmothoe sarsi</i>														
Kinberg	—	—	1	0.002	2	0.025	—	—	5	0.03	12	0.055	5	0.55
<i>Terebellides strömi</i>														
Sars	—	—	—	—	11	0.23	—	—	—	—	4	0.14	—	—
<i>Scoloplos armiger</i>														
(O.F.M.)	—	—	—	—	—	—	—	—	—	—	—	—	115	3.9
<i>Halicryptus spinulosus</i>														
Siebold	12	0.33	3	0.163	4	0.114	5	0.02	—	—	1	0.22	—	—
<i>Diastylis rathkei</i>														
(Krøyer)	—	—	—	—	1	0.02	—	—	—	—	6	0.106	10	0.175
Others	20.83	0.355	6.6	1.125	8.3	1.595	—	7.3	—	—	13.3	16.93	—	—
	234.83	77.255	824.6	42.789	197.3	15.964	977	70.50	607	19.96	652.3	27.051	130	4.625

of Gothland Deep. This has resulted in the creation of a dead zone for bottom animals (Fig. 22).

If in 1949/50 the bottom fauna in the Gothland Deep was encountered unto 150 m depth, in 1958 and 1959 it could only be traced to a depth of 78 m. Only at one place the benthos biomass values reached 4.62 g/m² at 90 m depth; here *Harmothoe sarsi*, *Terebellides strömi*, and *Diastylis rathkei* were found.

Thus the depth limit for the life of bottom animals should be considered to be 90 m, though the feeding grounds of fish in 1959 were confined to an area of about 78 m depth (biomass of bottom animals 27.05 g/m²) as compared with 120 m in 1949 when the benthos biomass was 1.9 g/m².

In 1949/50 all Vermes species had a very wide distribution and populated the whole of the eastern and northern Baltic, whereas in 1959 *Priapulius caudatus* had entirely disappeared and *Scoloplos armiger* was registered only at one station at the southern end of the Gothland Island.

In spite of their low numbers *Terebellides strömi*, *Harmothoe sarsi*, and *Halicryptus spinulosus* were distributed throughout the eastern Baltic to a depth of 78 m, and in the northern Baltic to a depth of 115 m.

The relict crustacean forms *Pontoporeia affinis* and *Pontoporeia femorata* were characterized in 1949/50 by their low numerical strength and correspondingly low biomass.

In 1959 the abundance and biomass of these species had increased to 300—700 specimens per m² (see Table 10). At the same time *Diastylis rathkei* had completely disappeared from the bottom fauna of the northern Baltic. This species was not encountered along the eastern continental coast above Liepaja and had moved from the shore to the zone of 80 m depth. In 1949 this species was widespread over the whole eastern and northern Baltic. Opposite Ventspils it was so abundant that *Diastylis rathkei* constituted one of the food components in the diet of the young cod (25—30 cm); in some cases from 200 to 250 specimens of this species were found in the stomach of a single cod.

A. T. SHURIN

Reference

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PART III.

THE FISH

A. Distant Northern Seas

Redfish

Table 1. Length frequencies of redfish caught with shrimp trawl by M/C "Adolf Jensen" in Godthåb fjord, 64°25'N, 50°19'W

Date, 1959	Number of hauls	Length in centimetres																				Number of fish
		6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24		
March	1	1	—	3	3	47	201	250	129	197	294	160	77	44	60	67	65	54	62	51	2,117 1,986 634 871 747 967	
June	1	10	37	39	33	59	147	262	326	186	191	247	127	44	30	33	36	11	12	8		
June	1	1	38	62	8	17	27	78	105	61	36	66	48	18	11	12	6	7	6	5		
Oct.	1	—	4	47	40	12	9	26	50	70	60	54	86	83	31	36	20	40	40	43		
Nov.	1	1	1	26	32	7	8	20	57	87	54	45	74	76	44	19	20	20	34	23		
Dec.	1	—	3	21	53	12	8	10	46	101	98	65	85	107	67	32	31	49	43	34		
Date, 1959	Number of hauls	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	>40		Number of fish		
March	1	50	46	25	29	29	25	25	15	11	16	23	16	15	8	9	3	7		2,117		
June	1	13	4	4	4	2	5	5	12	10	7	8	12	9	21	12	7	13		1,986		
June	1	3	3	4	2	—	1	—	1	2	—	—	2	2	—	—	1	2		634		
Oct.	1	34	26	19	16	7	2	3	6	—	1	1	—	1	1	—	—	3		871		
Nov.	1	21	15	19	9	11	5	3	3	1	—	—	3	2	1	2	3	1		747		
Dec.	1	17	21	16	17	6	4	6	7	—	4	1	2	—	—	—	1	—		967		

Danish Investigations in West Greenland

(Table 1)

The fishing experiments with shrimp trawl at Pisigsarfik in Godthåb fjord for small redfish have been continued. Six hauls were made, distributed over the months March, June, October, November, and December. A total of 7,319 redfish were caught and measured (see Table 1). Otoliths for age analyses were collected from portions of the sample.

P. M. HANSEN

Rare Fish

Germany

The German scientific institutions in Hamburg and Bremerhaven received in 1959 a number of remarkable fishes, most of which were collected during a single cruise of F.R.S. "Anton Dohrn" in April/May. Since the publication of a survey of the ichthyofauna of the Faroe-Iceland Ridge is in preparation here will only be mentioned a few species from the "Anton Dohrn" collection, which either have not been recorded before or were caught outside the area of the Faroe-Iceland Ridge.

Besides, we give here all the records of rare fishes obtained by commercial fishing vessels; the length measurements represent the total length to the cm below. The station numbers of the "Anton Dohrn" catches are added in brackets. The identifications of the species have been made by the author with exception of the two *Beryx*, which were recorded by Dr. KOTTHAUS.

Beryx decadactylus Cuvier & Valenciennes 1829

End of January 1959, Lofoten, 1♂, 52 cm

(caught by trawler).

End of March 1959, Røst, 1♂, 53 cm

(caught by trawler).

Ceratias holboelli Krøyer 1844

24. 1. 1959, Iceland-Faroe Ridge, 1♀, 110 cm with attached ♂, 8 cm (caught by trawler).

8. 6. 1959, W Greenland (Banana Bank), 270 m depth, 1♀, 127 cm with attached ♂, 16 cm (caught by trawler).

Cottunculus thomsonii (Günther 1882)

3. 5. 1959, 63°09'N—13°08'W, 730—760 m depth, (AD 3255), 1♀, 18 cm.

Diaphus rafinesquei (Cocco 1820)

21. 4. 1959, 61°55'N—17°00'W, 800 m wire out, (AD 3203), 1, 7 cm (Isaac-Kidd Mid-water Trawl).

Himantolophus groenlandicus Reinhardt 1837

16. 8. 1959, Iceland-Faroe Ridge, 1♀, 38 cm (caught by trawler).

Lampanyctus intricarius Tåning 1928

21. 4. 1959, 61°55'N—17°00'W, 800 m wire out, (AD 3203), 1, 11 cm (IKMT).

Lepidorhombus boscai (Risso 1810)

20. 4. 1959, 59°00'N—13°58'W, 510 m depth, (AD 3199), 1, 23 cm.

4. 5. 1959, 60°33'N—12°34'W, 400 m depth, (AD 3258), 1♂, 19 cm, 1♀, 22 cm.

Lycodes pallidus pallidus Collett 1879

3. 5. 1959, 63°09'N—13°08'W, 730—760 m depth, (AD 3255), 1, 20 cm.
6. 5. 1959, 61°15'N—08°05'W, 750—805 m depth, (AD 3267), 13, 16—24 cm.

Lycodes seminudus Reinhardt 1838

28. 4. 1959, 64°44'N—11°42'W, 320—330 m depth, (AD 3217), 1, 28 cm.

Paraliparis bathybi Collett 1879

6. 5. 1959, 61°15'N—08°05'W, 750—805 m depth, (AD 3267), 2, 22 and 24 cm.

Raja hyperborea Collett 1878

6. 5. 1959, 61°15'N—08°05'W, 750—805 m depth, (AD 3267), 1♂, 82 cm.

Rhinochimaera atlantica Holt & Byrne 1909

- End of December, SW Iceland (W of "Mehlsack"), 520 m depth, 2♀♀, 137 and 140 cm (caught by trawler).

G. KREFFT

B. Near Northern Seas

Sampling of Plaice Eggs from Dutch Lightvessels

(Figure 1)

For four successive years, viz. 1956—1959, plaice eggs have been collected from the lightvessel "Texel", 53°01'N, 4°22'E; in addition, plaice eggs were sampled from the lightvessel "Noord Hinder", 51°39'N, 2°34'E, during the years 1956 and 1958.

The results of these observations are shown in Figure 1. The eggs were caught with a 1 m² plankton net made of saran with a mesh size of 1.2 mm. The net was shot every tide as soon as the tidal current was strong enough to bring the net in a proper position below the surface. Only the flood observations are given here. By means of meter readings, showing the strength of the current, all observations were adjusted to "total number of eggs during a complete tide". All data given in the figure are averages for periods of 5 days.

The stage of development of the eggs was determined in each sample. Five stages were distinguished; the eggs in the last stage of development, immediately prior to hatching, were considered "ripe eggs". For the lightvessel "Texel" the strength and the direction of the current (flood tide only), and the surface temperature, are also given for periods of 5 days.

The object of these observations was to collect information on the duration of the spawning season, the maturation of the eggs in inshore waters, and — if possible — the intensity of spawning of the Southern Bight spawning population. As complete surveys over the whole of the spawning area were impossible, an effort was made to estimate the

success of spawning by sampling at one locality only, viz. the lightvessel "Texel". This lightvessel is probably well situated for this purpose: the influence of low salinity waters is usually slight, as demonstrated by temperature and salinity observations (POSTUMA, verbal communication), and the residual current from the southern North Sea carries a great deal of the southern waters through the "Texel" area.

Nevertheless it is open to doubt whether this sampling method can be regarded as truly representative. Only surface samples were taken; the wind direction may cause the main "flow of eggs" to drift away from the lightvessel area (in 1956, for instance, the current was more northerly than in the other years). However, some research ship cruises, working a grid of Hensen-net stations in the vicinity of the lightvessel, have shown that the lightvessel samples gave a rough idea of the egg concentrations in the "Texel" area.

As the L/V "Texel" lies well outside the main spawning area (SIMPSON, in GRAHAM, "Seafisheries", 1956) the samples may show only the proportion of ripe eggs reaching inshore waters, and thus the nursery grounds of the plaice larvae.

It is still too early to conclude whether our sampling of eggs gives a reliable picture of the relation between intensity of spawning of the Southern Bight plaice and the recruitment, for, of the years under consideration 1956 is the only one of which the strength of the year-class of plaice is known. The 1956 year-class was a fairly good year-class in the Dutch landings, which seems to tally

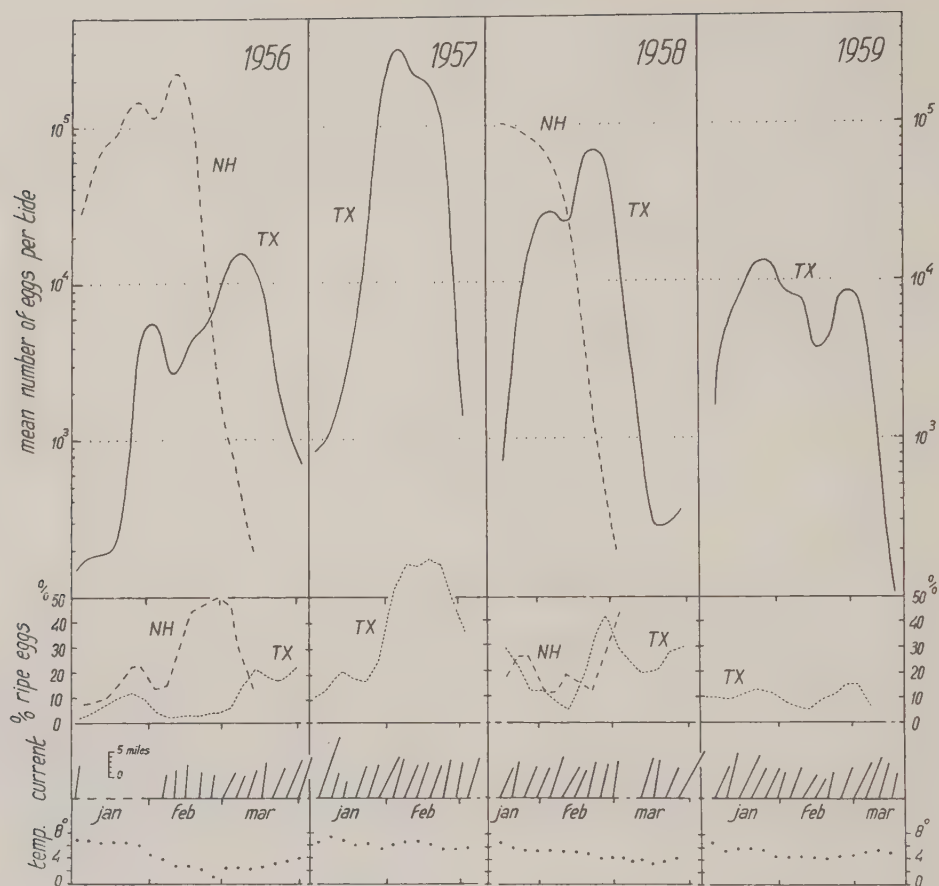


Figure 1. Abundance and developmental stage of plaice eggs in plankton samples collected from Dutch lightvessels with data on residual current and surface temperatures referring to the lightvessel "Texel".

with the prolonged period during which relatively high numbers of eggs were found in the lightvessel samples. There are indications that the 1957 year-class may be slightly above normal. Very high numbers of eggs were collected then, but during a relatively short period only. Remarkable was, however, the high percentage of ripe eggs in 1957, compared with other years. The years to come will teach us whether or not this method of sampling will be useful for our purpose.

M. ROESSINGH

Sole

German Tagging Experiments in 1959

(Figures 2-7; Tables 2-3)

Liberation data

(1) From June to October 1959, 441 soles were tagged on board the research vessels "Anton Dohrn" and "Uthörn". The length distribution of

Table 2.

Number of tagging station	Position N	E	Number of fish tagged	Number of returns
1	54°15'	7°46'	296	23
2	54°17'	7°40'	18	2
3	54°13'	7°20'	4	—
4	54°24'	7°07'	7	1
5	53°38'	5°38'	2	—
6	53°03'	4°01'	1	—
7	53°18'	3°16'30"	3	1
8	53°39'	2°43'	1	1
9	55°51'	7°44'	30	2
10	55°46'	7°37'	5	—
11	55°04'	8°04'30"	23	—
12	54°49'	8°06'30"	27	2
13	54°26'	8°04'	6	1
14	54°07'	7°57'30"	4	—
15	54°45'	6°11'	14	—

the tagged fish is depicted in Figure 2. Only 9 fish were below 20 cm in total length.

(2) In the vicinity of Helgoland 318 sole (= 72.3%) were liberated; in the North Friesian

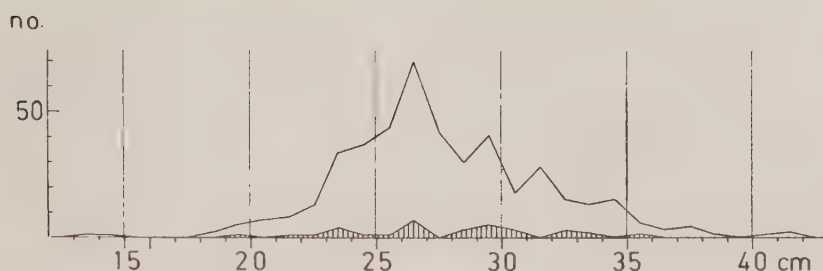


Figure 2. Length composition of the tagged soles and of those returned.

coastal waters 91 (= 20.7%) were liberated and 32 fish (= 7%) were liberated at various places in the southern North Sea. Details about the positions of liberation, the number of fish tagged, and the number of returns are given in Table 2.

(3) Type of tag: yellow and red Petersen discs were used inscribed "BAH" and a serial number. The discs were connected with silver wire of 1 mm in diameter.

(4) Method of tagging: the tags were attached nearly in the middle of the fish and somewhat ventral to the interneurons at the dorsal side of the

fish. In order to keep the fish quiet and to avoid damage during the tagging operation they were lightly pressed between two wooden boards covered with foam rubber sheathing and hinged with the same material. In the middle of the outer margin of each of the boards a rectangle of 4×8 cm was cut out.

Recapture data

(1) Up to 29. February 1960 the number of returns amounted to 33 fish, i. e., 7.5% of the total number of fish tagged. Details about the recaptures are listed in Table 3.

Table 3.

No. of tag	Date of recapture	Position of recapture	Distance from place of libe- ration (n. miles)	Days in sea	Length difference in mm	Recovered by
13	4. I. 60	53°25'N, 4°05'E	140	137	+17	Holland
28	23. X. 59	54°28'N, 6°05'E	60	63	+ 8	Holland
41	3. IX. 59	8 sm. SW of Helgoland	app. 11	14	—10	Germany
80	27. IX. 59	11 sm. WNW of Helgoland	app. 7	38	+10	France
84	15. XI. 59	54°13'N, 5°25'E	82	87	— 2	Belgium
105	27. IX. 59	11 sm. WNW of Helgoland	app. 7	19	0	France
219	4. VII. 59	54°40'N, 07°40'E	25	11	— 2	Belgium
225	19. XI. 59	54°20'N, 05°50'E	67	149	+25	Holland
231	3. IX. 59	10 sm. SW of Helgoland	app. 6	78	0	France
237	4. II. 60	55°05'N, 04°50'E	113	226	— 3	England
245	4. VII. 59	54°40'N, 07°40'E	25	11	— 1	Belgium
251	5. X. 59	3 sm. NE of FSP 12	app. 14	104	abt. +30	France
256	11. XII. 59	55°20'N, 05°38'E	100	171	+23	Holland
266	6. VIII. 59	54°15'N, 06°30'E	45	44	0	Holland
267	17. XII. 59	53°50'N, 05°50'E	72	177	— 4	Holland
270	12. X. 59	54°24'N, 05°15'E	100	110	+ 7	Belgium
274	Nov. 59	53°35'N, 03°50'E	app. 130/140	147	+ 3	Holland
296	28. VI. 59	4 sm. SE of Helgoland	app. 11	4	— 1	Belgium
298	16. VII. 59	W of H 1	app. 16	22	— 1	Germany
304	12. X. 59	54°19'N, 07°20'E	19	110	+16	Germany
320	29. XII. 59	54°20'N, 04°20'E	118	188	+ 6	Holland
325	4. VIII. 59	54°17'N, 06°40'E	21	41	+ 1	Belgium
338	14. XI. 59	54°15'N, 03°30'E	125	143	+ 2	England
348	27. VIII. 59	53°15'N, 03°20'E	4	59	+19	Holland
350	15. VIII. 59	53°33'N, 02°24'E	12	47	+ 4	England
357	3. X. 59	56°04'N, 07°47'E	13	94	?	Danmark
375	13. I. 60	53°50'N, 05°00'E	163	195	+ 9	Holland
420	24. I. 60	54°20'N, 05°30'E	96	205	+19	Holland
426	12. XI. 59	53°35'N, 04°05'E	165	133	+27	Holland
439	22. XI. 59	53°15'N, 04°03'E	158	172	+22	Holland
449	12. IX. 59	W of Helgoland	app. 3	30	?	Germany
477	7. I. 60	54°15'N, 05°25'E	81	136	+15	Holland
500	14. X. 59	54°22'N, 06°50'E	33	55	—10	Germany

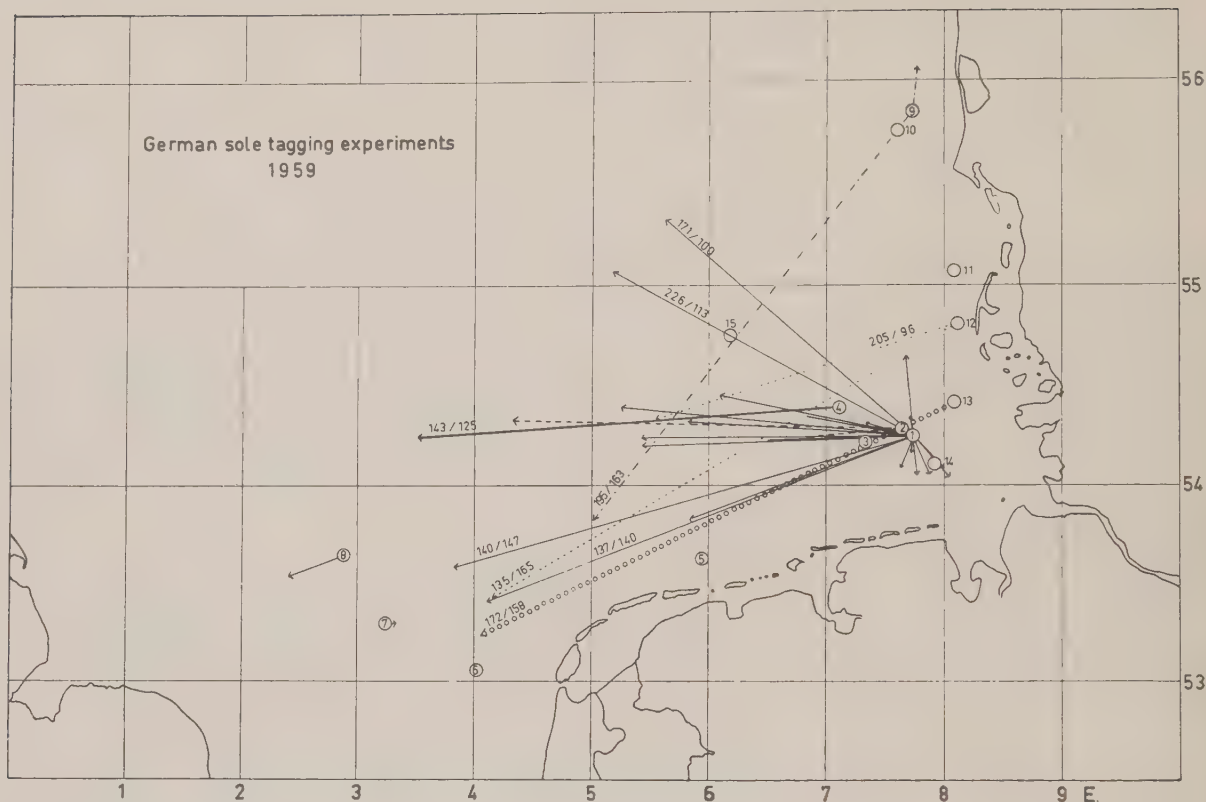


Figure 3.

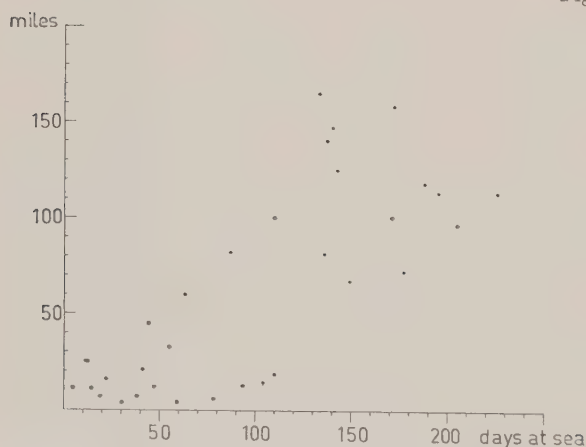


Figure 4. Distance between place of release and recapture.

(2) Migration: As Figure 2 shows, the migrations of the sole of the south-eastern North Sea are mainly directed westwards in the second half of the year. This is in accordance with the statement of BÜCKMANN (Ber. Dtsch. wiss. Komm. Meeresforsch., 7, 1934) that the sole of the German Bight migrate in early autumn from the shallower coastal waters to the deeper layers of the southern North Sea.

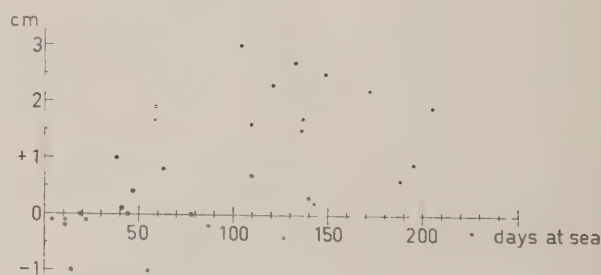


Figure 5. Difference between length at recapture and length at release.

Only a few sole were recovered south or south-east of tagging position No. 1, NW of Helgoland, and only one fish to the north and two to the north-west of this position. The distances between liberation and recovering locality are sometimes very great (Figures 3 and 4), and show that the sole is considerably more active than is generally supposed. Migrations of over one mile per day are not rare.

(3) Growth: If we compare the length of the fish at liberation and recovery (Figure 5) it is seen that some fish are shorter at recapture than at

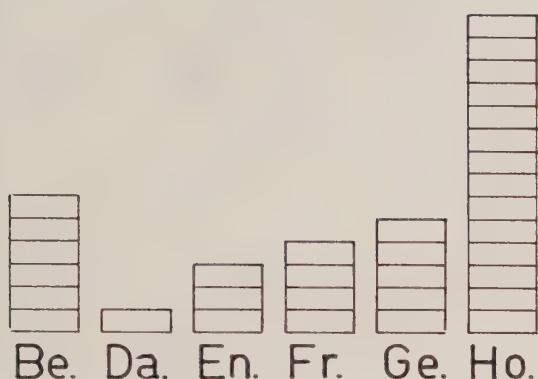


Figure 6. Number of returns by countries.

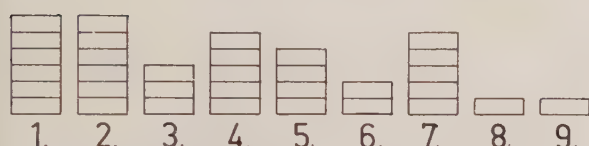


Figure 7. Number of returns in the first nine months after liberation.

liberation, especially in the first weeks after tagging. This is due to the fact that most of the recaptured fish were gutted, put on ice, and measured when landed. A shrinkage of some mm may result. In most cases, however, the fish show a growth of up to 3 cm. When considering the fact that the main feeding season of the sole lies within the first six months of the year, the length increment corresponds well with BÜCKMANN's (loc. cit.) conceptions of the growth of the sole.

(4) Figure 6 shows the recoveries by countries (each rectangle represents one fish) and Figure 7 shows the number of recoveries within each of the first nine months after tagging.

ADOLF KOTTHAUS

Dutch Sole Tagging Experiments, 1959

(Figures 8-13)

According to a 1958 recommendation of the ICES a sole tagging programme was started, in close cooperation with England, Denmark, Germany, and Belgium.

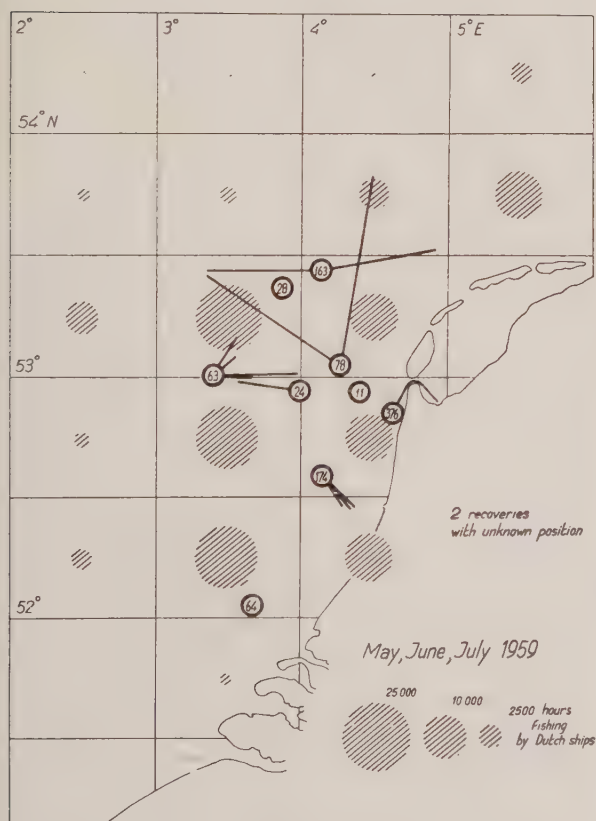


Figure 8.

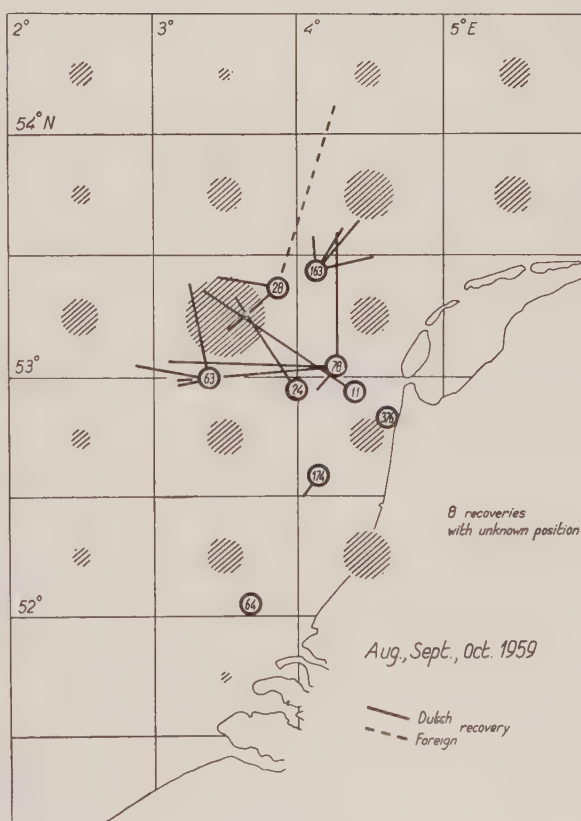


Figure 9.

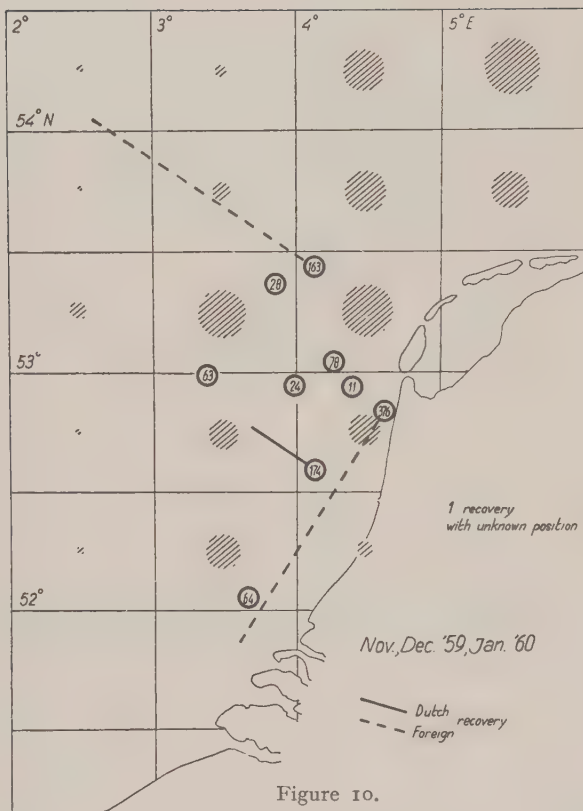


Figure 10.

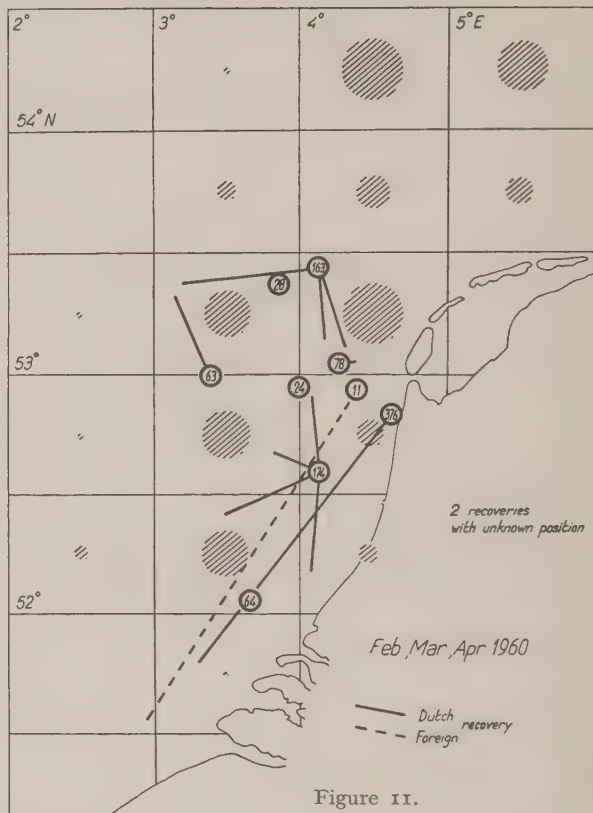


Figure 11.

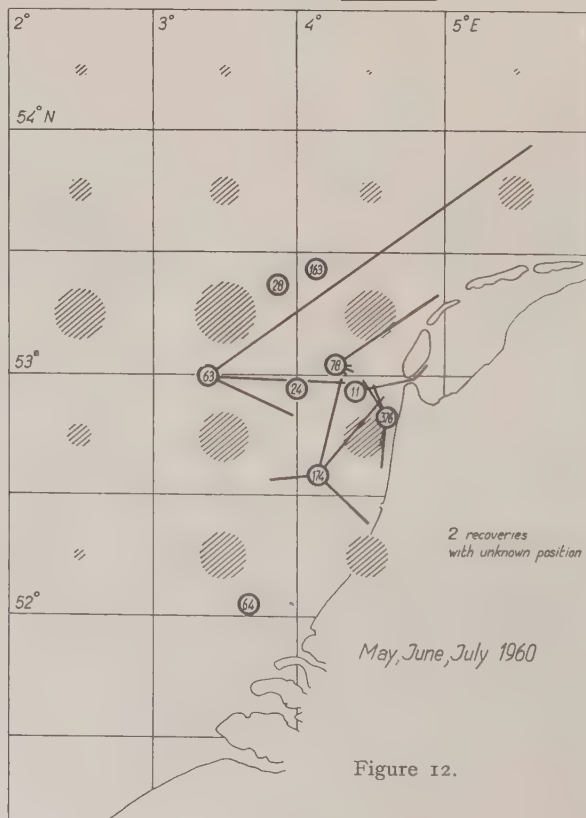


Figure 12.

Figures 8-12.
Sole tagging.
Release positions,
numbers of
soles tagged
and recovery
localities.
Shaded circles
indicate hours
of fishing by
the Dutch fleet
for a period
of three months.

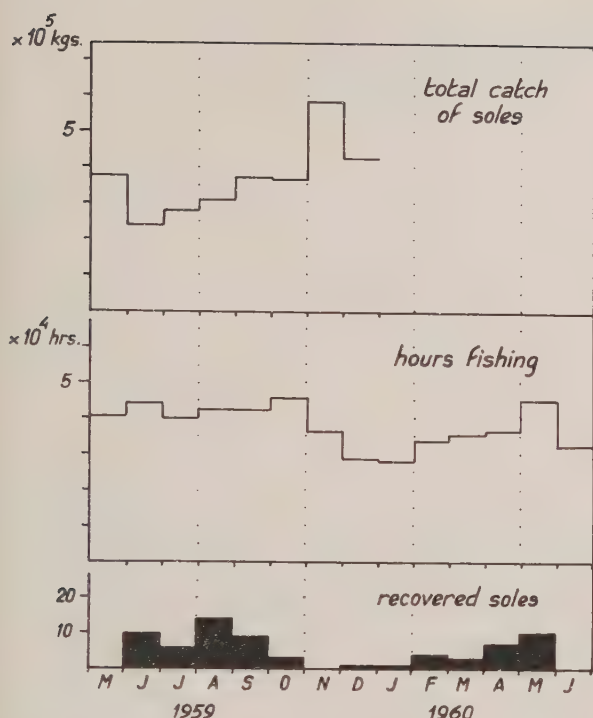


Figure 13. Rate of recovery of tagged soles by Dutch vessels in relation to fishing effort and total catch of soles by Dutch ships, in the area enclosed by 2°-6°E and 51°30'-54°30'N.

The Dutch effort covered some 1,000 soles tagged in the coastal areas in the months of May and June 1959, at positions shown in Figure 8 (open circles). Use was made of the red plastic Albrechtsen tags, which were attached near the tail. The recoveries obtained thus far are shown for successive periods of 3 months (Figs. 8-13). The ciphers placed in the open circles give the numbers of fish tagged at the relevant positions. Each heavy line connects the position of release with the place of recapture of one fish. The unbroken lines are Dutch, the broken lines represent foreign recoveries.

The chance of a fish to get caught in a trawl is proportional to the fishing effort. Therefore, the distribution of the fishing effort has to be taken into account in the interpretation of the results of a tagging experiment. The shaded circles in Figures 8-12 are proportional to the total number of fishing hours of Dutch vessels in the corresponding quarters and statistical rectangles. These fishing hours have not been corrected for the fishing power of the ships.

Comparison of the data on the Dutch fishing effort with the number of recoveries made by Dutch

vessels gives an indication of the "availability" and/or of migrations of the tagged soles.

The number of recoveries clearly declined towards the end of 1959 (see Fig. 13) but increased again in the spring of 1960. Though the fishing effort in the area covered by the rectangles shown in Figures 8 to 12 reveals in winter a decreasing tendency too, this decline alone cannot account for the considerable drop in the recovery rate. Though Figure 10 reveals a fair amount of fishing in the releasing areas in the winter of 1959/1960, only 2 recoveries (one at sea, one in the fish market), are recorded for that period.

The total catch of soles in the area did, however, increase during autumn and winter 1959, which indicates that a large population of soles must have been present there.

The relative absence of recoveries in winter could be explained in terms of migration of the tagged soles out of the area worked by the Dutch fleet. The two foreign recoveries in Figure 10, one English and one Belgian, do support this migration assumption. The increasing number of recoveries in spring and summer of the year 1960 gives the impression that the soles did return to their initial positions.

J. F. DE VEEN

Danish Investigations on Flatfish in the Skagerak-Kattegat Area

(Tables 4-6)

Coastal investigations of the 0- and I-groups

As in previous years the Johansen young-plaice trawl used in water of 1-2 m depth was fitted with an iron chain in front of the footrope.

Table 4 shows that in the Skagerak three-quarters of the normal density of 0-group plaice was found, but on account of the heavy swell during the fishing the catch was undoubtedly too low. Only

Table 4. Numbers of 0- and I-group plaice caught per hour with the Johansen young-plaice trawl in Danish coastal waters in July/August 1958 and 1959

(Preliminary figures, corrected to trawl without chain. The means are for the period 1905 to 1958)

	Number of stat.	0-group		I-group		
		1959	1958	1959	Mean	1958
Skagerak	6	—	46	68	—	33
N. Kattegat	12	148	188	97	118	105
C. Kattegat	6	18	16	37	26	6
S. Kattegat	14	63	174	20	20	3

Table 5. Danish catches of plaice per hour's trawling in 1959

(Preliminary figures. Lengths to the nearest lower whole cm. S = Standard trawl, H = *Nephrops* trawl)

	Depth, m	Gear	Number of stat.	Age-groups							Centimetre groups							Total
				0	I	II	III	IV	V	VI	6-10	11-15	16-20	21-25	26-30	31-35	36-40	
<i>Northern Kattegat</i>																		
June	6-14	S	5	—	0.4	251	63	20	—	—	0.4	26	120	144	43	0.4	—	334
	15-24	S	4	—	12	265	11	—	—	—	8	34	159	66	20	1	—	288
	44-54	H	9	—	0.2	11	2	0.3	—	—	—	—	2	4	4	2	1	13
Oct.-Nov.	6-14	S	6	15	47	117	1	—	—	—	16	31	31	70	30	2	—	180
	10	H	1	—	2	6	—	—	—	—	—	—	4	2	—	2	—	8
	15-24	S	9	50	21	53	1	—	—	—	50	8	24	30	10	1	1	124
	16	H	2	—	14	34	2	—	—	—	—	9	8	14	9	8	2	50
	25-34	S	6	2	23	82	1	—	—	—	2	16	25	49	13	2	1	108
	35-52	S	5	—	10	26	—	—	—	—	—	7	8	16	5	0.4	1	36
	41-86	H	7	0.3	3	8	1	—	—	—	0.3	0.3	3	5	2	1	1	12
	<i>Central Kattegat</i>																	
June-July	8-13	S	5	—	0.4	11	16	0.4	—	0.4	—	0.4	11	16	0.4	—	0.4	28

the Tannis Bay, the northernmost part of the coast, was investigated.

In the northern Kattegat the 1959 year-class of plaice was about twice the normal in July, and relatively many were found in trawl catches from the R/V "Biologen" in the 6-14 m depth zone in October/November (see below).

At the coast of the central Kattegat the frequency of the 0-group was about half the normal, but in the southern Kattegat its frequency was as high as nine times the normal.

The number of I-group plaice was twice the normal at the coast of the northern Kattegat. This year-class was also as 0-group, in 1958, found in larger numbers than normally. In the central and southern Kattegat I-group plaice were found in rather small numbers, in the central Kattegat about half of the normal, and in the southern Kattegat about the normal. Here growth is usually so good that most of them leave the coast in their second year.

In the central Kattegat the 0-group flounder was found in relatively great numbers, and the I-group about three times the normal. In 1958 the 0-group flounders were found in numbers over the normal in both the central and the southern Kattegat.

The stock of plaice in the Kattegat at more than 5 m depth

The number of trawl hauls from the R/V "Biologen" and the mean number of the various age- and size groups of plaice in northern and central Kattegat are shown in Table 5. A commercial "lobster trawl" (for *Nephrops*) was used in some stations but the number of hauls for comparison of this gear with the standard trawl was not sufficient; therefore the catches are given separately for the two gears.

The table shows that the II-group, year-class 1957, was unusually numerous, and dominated the stock in the northern Kattegat. In November 1957 this year-class had immigrated to this region, no doubt from the central Kattegat (see Ann. Biol., 15: 74), and the fact that the density of this year-class was in June 1959 about three times that in November 1958, shows that a strong immigration must have taken place in the meanwhile.

The length of most of the II-group plaice was 16-22 cm, but some were over the Danish commercial size-limit, 26 cm, and naturally a great number of the smaller plaice passed this size-limit during their summer growth. They were fished very intensively during the summer (and had been fished since the autumn of 1957), together with the III-group plaice, most of which were over 26 cm in June. In June the III-group was found especially in the coastal waters, 6-14 m deep. The stock of this year-class too had increased between November 1958 and June 1959; here too immigration must have taken place. The fact that an increase in density of the stock is only observed in the coastal waters, is no doubt due to the intensive fishery, which led, in the waters over 14 m deep, to removal of a corresponding number of fish as did immigrate there. Fishing is considerably less intensive in the shallower coastal waters, since trawling and seining is prohibited there.

From June 1959 to October-November of that year the number of the III-group plaice had been reduced from about 15 per 1 hour haul (due regard taken to the relative areas of the depth zones) to less than 1 plaice per hour, whereas the II-group was reduced to about one fourth of the number found in June. In October-November about four fifths of the plaice of this age-group was below the commercial size-limit. In the northern Kattegat the

Table 6. Length distribution (%) and average length of plaice in Danish commercial catches from the Skagerak and Kattegat in 1959

(Length measurements to nearest lower whole cm. Averages corrected)

	Depth, m	Number of hauls	26-27	28-30	Length, cm					Mean
					31-35	36-40	41-45	45-50	51-55	
<i>Skagerak, N of the Scaw</i>										
1958, April-May	9-25	3	47	25	25	1	—	—	—	29.4
1959, March-April	13-38	7	37	36	25	3	0.4	—	—	29.6
1958, April	26	1	—	10	46	24	20	—	—	35.8
April-May	18-57	2	8	28	44	13	6	1	—	33.1
1959, April-May	19-66	3	3	16	33	39	10	2	—	31.6
<i>Northern Kattegat, near Skagen harbour</i>										
1957, March	6-13	3	49	41	9	1	—	—	—	27.9
1959, March-April	8-11	3	35	46	19	—	—	—	—	29.1
<i>Central Kattegat, 25 miles E of Hals</i>										
1958, August-September	10-14	3	55	29	15	1	—	—	—	28.6
1959, August-September	10-15	3	17	33	46	4	—	—	—	30.9
<i>Central Kattegat, 25 miles ESE of Hals</i>										
1958, October-December	12-13	2	5	47	45	2	—	—	—	30.9
1959, October-November	12-15	2	4	12	47	36	1	—	—	34.3
<i>Central Kattegat, 20 miles SE of Hals, 15 miles N of Djursland</i>										
1958, October-December	12-13	3	13	53	32	2	—	—	—	30.2
1959, October-November	8-14	4	4	21	47	28	0.5	—	—	33.7
<i>Southern Kattegat, 15 miles E of Grenaa</i>										
1958, December	30	1	8	18	40	22	13	—	—	34.6
1959, January	23-24	2	2	7	67	22	2	—	—	33.8
1959, December	30	1	1	11	28	60	—	—	—	35.7
<i>Southern Kattegat, at Schultz's Grund</i>										
1959, January	18	1	4	27	63	4	1	—	—	32.8
1959, December	18	1	3	10	42	27	18	—	—	35.9

average growth of the II-group plaice is from June to October—November only about 5 cm, which means a displacement from one size-group in the table to the next. The table clearly indicates that the number of undersized plaice also declined during the summer. The almost total disappearance of the III-group plaice between June and October—November can only partly be ascribed to the fishery, about 75% at most, neither can the relatively great reduction in numbers of the undersized II-group be explained in terms of destruction by the intensive fishing and natural mortality. Therefore, emigration must have taken place from this area.

It can be derived from Table 5 that the I-group in the northern Kattegat was in October/November about three times as numerous as in June. No doubt many I-group plaice came from waters less than 6 m deep. The coastal investigations of 1958 revealed that this year-class was stronger than normal in the northern Kattegat. In the 6—14 m depth zone the rich 1959 year-class too was found in relatively great numbers in October/November 1959.

In the central Kattegat the number of hauls was too small to give a reliable picture of the density of the stock. In June the III-group was here somewhat more numerous than the II-group. In

the few catches in the southern Kattegat the few plaice caught predominantly belonged to the III- and IV-groups.

Commercial catches of plaice in Skagerak and Kattegat

North of the Scaw and in the Aalbæk Bay the average length of the plaice in waters 15—35 m deep was, as usual, in March, April, and May very little over the Danish commercial size-limit (see Table 6). In somewhat deeper waters the size is usually slightly larger: in 1959 the average length was about 31.5 cm in waters 20—65 m deep, whereas it was about 33 cm in April—May, 1958. The numerous fish of the rich 1957 year-class led to a decline in their average length.

In the Aalbæk Bay the plaice were just over the size-limit. Here too most of the plaice are fished very soon after they have reached this size.

In the southern part of the Aalborg Bay the mean length of the plaice caught in autumn 1959 was some 4 cm larger than it was the year before on account of the rich 1957 year-class. The growth in this area is considerably better than near the Scaw, and the mean length of the 1957 year-class approached the sizelimit in 1958.

In the northern and north-eastern parts of the Aalborg Bay the mean length was almost the same

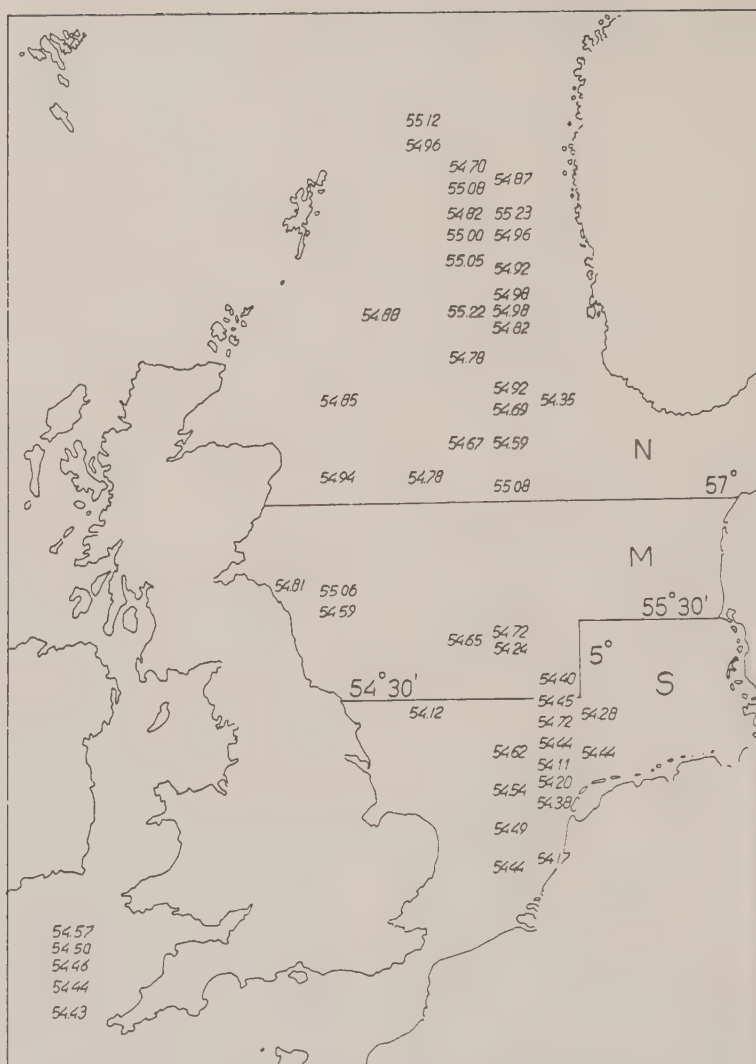


Figure 14. Average number of vertebrae in *Gadus merlangus*.
Number of whiting per sample: 50 specimens.

as in 1958, about 30 cm, since growth is somewhat poorer here; many of the plaice of the year-class 1957 were about and a little over the size-limit.

At the boundary between Kattegat and the Belts the average length in autumn 1959 was about 35 cm, about 2 cm more than a year before when the stock of commercial plaice was still for the greater part constituted by the rich year-class 1955.

AAGE J. C. JENSEN *

Whiting Investigations in the Netherlands

(Figures 14-18; Tables 7-8)

(a) Vertebral counts

Counting of vertebrae in whiting landed at IJmuiden was continued in 1958 and 1959. The general pattern observed was the same as in 1957 (Ann. Biol., 14: 82). The numbers given in Figure 14 are the averages of samples of 50 whiting each. The area sampled covers roughly the working area of the Dutch trawler fleet (north of 57°N, and the Irish Sea) and of the Dutch cutters (southern North Sea).

Figure 15 gives the averages of vertebral means for samples per half degree of latitude (method

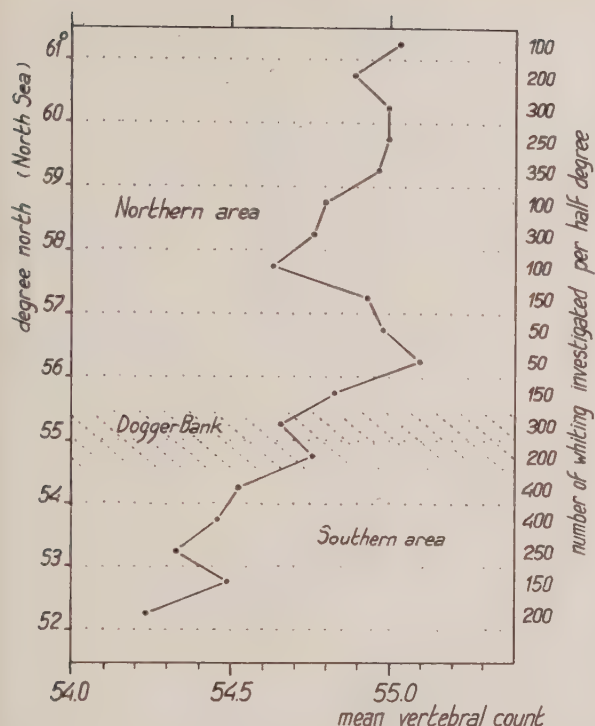


Figure 15. Average of vertebral means for samples per half degree of latitude.

developed by GAMBLE, C.M. 1959 : No. 36). All data collected in the Netherlands between 1956 and 1959 are incorporated in this figure. Striking is the rapid increase of vertebral means from south to north in the area south of the Dogger Bank, and the slow increase north of $55^{\circ}30'N$, which tallies with observations made by other investigators. Attention should be drawn to the fact that the main area of operation of the Dutch trawlers is the eastern part of the northern North Sea; it is therefore doubtful whether the number of samples from the western half gives a representative picture of vertebral means.

(b) Tagging experiments

In November, 200 whittings with Lea tags were released in the vicinity of IJmuiden in water 20 m deep. Though the number of recaptures is small, it is interesting to note that all returns came from the southern North Sea or the English Channel. Figure 16 shows 6 returns with exact catch positions, and 2 returns of which no precise data are known. These data give the impression that whiting may perform a southward migration during the winter months, along the Dutch and Belgian coasts, towards the Channel. All whiting tagged were between 20 and 27 cm, and belonged to the age-groups I and II.

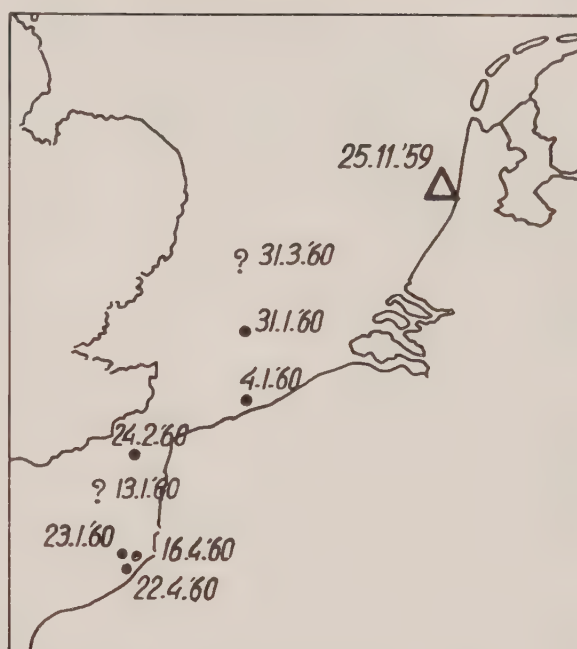


Figure 16. Dutch whiting taggings in the southern North Sea.

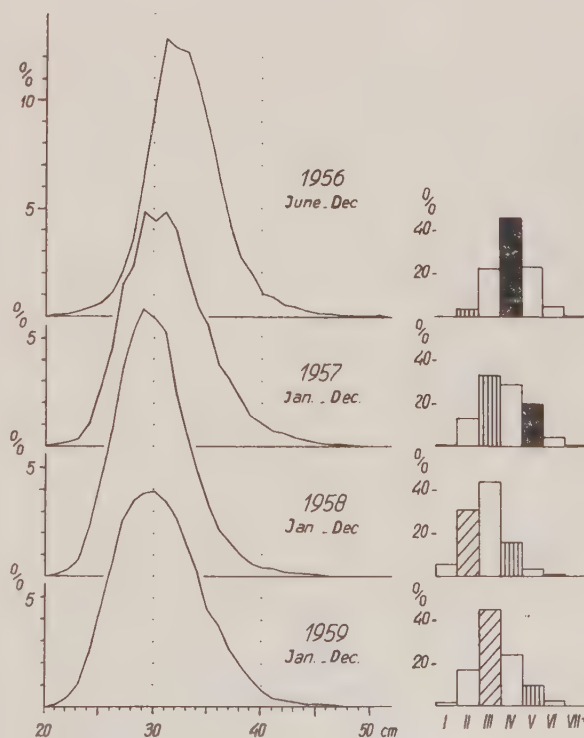


Figure 17. North Sea whiting; percentage length frequency and age distribution.

Figures 18a and 18b. North Sea whiting; length frequency and age distribution in numbers over 1958 and 1959.

Table 7. Landings of whiting by Dutch fishing vessels from the North Sea in 1958 and 1959

Area	Quarterly period	1958					1959				
		Weight landed × 1,000 kg	Number landed × 1,000	100 hours fishing	Weight landed/ 100 hrs	Number landed/ 100 hrs	Weight landed × 1,000 kg	Number landed × 1,000	100 hours fishing	Weight landed/ 100 hrs	Number landed/ 100 hrs
N	Jan.—Mar.	1,267	4,725	215	5,885	21,946	2,279	8,415	304	7,500	27,689
	Apr.—June	1,639	6,709	350	4,676	19,140	1,644	6,262	404	4,073	15,514
	July—Sept.	613	2,230	392	1,565	5,693	730	2,853	365	2,002	7,826
	Oct.—Dec.	740	3,128	310	2,416	10,104	935	4,213	255	3,671	16,543
	Total	4,267	16,792	1,267	3,367	13,251	5,588	21,743	1,327	4,212	16,387
M	Jan.—Mar.	—	—	—	—	—	27	150	146	184	1,025
	Apr.—June	106	510	96	1,100	5,290	61	218	84	726	2,594
	July—Sept.	267	956	320	834	2,985	375	1,609	367	1,021	4,382
	Oct.—Dec.	69	273	118	582	2,304	71	276	72	983	3,820
	Total	443	1,739	573	774	3,037	534	2,253	670	797	3,363
S	Jan.—Mar.	110	478	1,375	80	348	590	3,005	1,601	365	1,877
	Apr.—June	251	1,101	1,652	152	666	483	2,440	1,751	276	1,394
	July—Sept.	220	1,136	1,493	147	761	562	1,932	1,432	392	2,048
	Oct.—Dec.	616	3,333	1,249	493	2,669	670	3,542	1,392	562	2,972
	Total	1,197	6,048	5,769	207	1,048	2,305	11,919	5,975	386	1,994

Table 8. Number of whiting per 100 hrs fishing

		Age-group	I	II	III	IV	V	VI	VII+
1957		Total	6	328	813	711	494	103	10
1958		N	488	3,688	6,470	1,975	508	107	13
1958		S	33	443	355	178	34	3	1
1959		N	346	2,134	6,598	4,720	2,139	395	52
1959		S	77	508	960	327	71	46	6

(c) Statistics and market measurements

Figures 17 and 18 and Tables 7 and 8 give a summary of the Netherlands' market measurements 1956—1959, and of the market statistics for the years 1958 and 1959.

Some 25,000 whittings are measured every year in the IJmuiden Market and every fortnight a sample of 50 specimens is taken for age determination. The age readings were mainly made by Mr. K. Kuiten. Figure 17 shows the percentage length frequency distribution and the percentage age distribution for the whole of the North Sea. The figures reveal that 1952 and 1955 have produced good year-classes, and that the 1956 year-class is above normal. The southern area — S in Figure 14 — is responsible for this good 1956 year-class, as may be derived from Figure 18b (3 year-old whiting in the age distribution in the southern area). The modus of the length distribution in Figure 17 moves from 32 cm (second half year 1956) down to 29 cm in 1958, but does increase again in 1959. In 1958 about 75% of the catch consisted of 2 and 3 year-old whiting, whereas in 1959 about 70% of the whiting was 3 and 4 year-olds; this may explain the moving modus.

In figures 18a and b the length and age distribution for the years 1958 and 1959 respectively, is shown in absolute numbers for the different areas indicated in Figure 14. The northern area is exclusively fished by trawlers, the southern almost exclusively by cutters; whereas the middle area is fished by both types of vessels. A striking difference in length composition is demonstrated. In all areas the catch increased considerably: after the low figures in 1957 (4,711 tons), the landings rose to 6,241 tons in 1958, and to 8,525 tons in 1959 which latter figure represents a maximum in the Dutch landings. This is partly due to biological circumstances and to an increasing number of fishing hours (Table 7), but without doubt also to the increasing motor power of the Dutch fleet and to the poor catches of some other species. Whiting is always considered a by-catch by Dutch fishermen; as soon as the catch of other species, especially of herring and mackerel, is good, the whiting is to a certain extent rejected. This factor is also responsible for the considerable fluctuations in the catches per unit of effort shown in the tables.

M. ROESSINGH

- Torpedo nobiliana* Bonaparte—4: off Clythness, II; off Macduff, IV; off Aberdeen, VI; Shetland, X.
- Acipenser sturio* L.—5: Buchan Ness, III; 80'E Aberdeen, IV; West of Scotland, V; Firth of Forth, VIII; off Macduff, XII.
- Alosa alosa* (L.)—2: Firth of Clyde, I; Sumburgh Hd., Shetland, VIII.
- Alosa finta* (Cuvier)—4: off Wick I; off Lossiemouth, II; 60'E Aberdeen, III; 72'NNE Fraserburgh, III.
- Engraulis encrasicolus* (L.)—2: Buchan Deep, XII (8 fish); St. Abbs Hd., XII (3 fish).
- Notoscopelus elongatus* (Costa)—1: 56°32'N — 9°06'W, VI.
- Scomberesox saurus* (Walbaum)—9: St. Andrews, I; St. Abbs, II; 59°20'N—5°20'W, X; Isle of Tiree, X; Loch Fleet, XI; Berneray, XI; Lochmaddy, XII; NE of Foula, XII; Unst, Shetland, XII. These records were mainly from strandings, involving, in several cases, large numbers of fish.
- Belone belone* (L.)—5: Shetland, II; NE North Sea, III, IV; 6'NW Hoy, Orkney, VIII.
- Lampris guttatus* (Brünnich)—2: Shetland, VI, VIII.
- Trachipterus arcticus* (Brünnich)—1: 7'SE Fuglø, II.
- Hoplostethus mediterraneus*—1: West of St. Kilda, VI (4 fish).
- Polyprion americanum* (Schneider)—1: off North Rona, VI.
- Epigonus telescopus* (Risso)—1: West of St. Kilda, VI (17 fish).
- Naucratus ductor* (L.)—1: North Minch, IX.
- Brama raii* (Bloch)—9: Syderø, VII; W. Orkney, VIII; Flugga, VIII, IX (2 records); Sule Skerry, IX; Ronas Voe, IX; Fair Isle, X; Farne Islands, XII.
- Spondyliosoma cantharus* (Gmelin)—4: 23'NE × E Wick, I; Viking Bank, II; off Foula, II; 6'N × E Buckie, XII.
- Box boops* (L.)—1: 4'S Portree, Isle of Skye, IX (second Scottish record).
- Cepola rubescens* L.—1: NE Irish coast, IX.
- Trachinus draco* L.—4: off Macduff, III; off Arbroath, IV; Wee Bankie, V; Shetland, VII.
- Aphanopus carbo* Lowe—2: 60'WNW George Bligh Bk., VII; West of St. Kilda, IX (20 fish).
- Anarhichas latifrons* Steenstrup & Hallgrímsson—1: 110'NE × E Aberdeen, IV.
- Centrolophus niger* (Gmelin)—5: Wee Bankie off Firth of Forth, VII; off Noup Hd., VIII, XII; 56°50'N—7°00'W, VIII; 15'NE Buckie, IX.
- Mugil chelo* Cuvier—1: Mouth of River Dee, Aberdeen, VII.
- Mola mola* (L.)—2: 52°30'N—20°00'W, VIII; Shetland, IX.

BENNET B. RAE
J. M. LAMONT

C. Baltic-Belt Seas

Eggs and Larvae of Various Species

(Table 13)

In the 1959 spawning season, the average number of eggs per m² near the "Fehmarnbelt" lightvessel were as given in Table 13.

The number of cod eggs was still very low, though somewhat higher than in the year before. The time of spawning was normal for the cod, as well as for the plaice, the latter showing the same very low number of eggs as has been usual during all the years under consideration. The quantity of flounder eggs was higher than in 1958, whereas the spawning of the dab was of the same intensity. Sprat eggs which have been very scarce during recent years were totally absent, an alarming symptom of the poverty of the stock of adult fish. Obviously the higher water temperatures in the summer were very favourable for the spawning of mackerel in the Fehmarnbelt (77 per m² on 11. June). The majority were in the first stages of development, and few contained an embryo. Only one mackerel larva, 9 mm in length, was found later (7. July).

In order to see how far the frequency of pelagic fish eggs at the "Fehmarnbelt" lightvessel is to be considered as representative of the spawning intensity in the whole area, monthly vertical and horizontal hauls with fish-brood nets were carried out at 3 stations in the eastern, central, and western part of the Kiel Bay. If the egg numbers per m² observed in each month are summed up for each species, the data set out in Table 13a are obtained.

The eggs were more numerous in the Kiel Bay proper than in the Belt, with exception of the

mackerel eggs. The differences between the stations are considerable for the cod and plaice which began to spawn in the middle of December. The highest egg number per m² was 159 for the cod (6. III.), and 12 for the plaice (6. III. and 23. III.). The eggs of the flounder and dab were distributed rather irregularly; sprat eggs which were totally absent in the Belt, were present in rather small quantities in Kiel Bay. Compared with the egg numbers of the indigenous species, the frequency of mackerel eggs in 1959 is very remarkable. On the same day (6. June) hauls were made at all stations in the Fehmarnbelt and in the Kiel Bay. Corresponding to the 77 eggs per m² caught at the "Fehmarnbelt" lightvessel, 51 were obtained at the Winds Grav, and 39 south of Langeland.

These control observations in the Kiel Bay show that the results of quantitative hauls near the "Fehmarnbelt" lightvessel must be taken with reservation as representative for the whole area.

R. KÄNDLER

Quantitative Fishing of Demersal Fish with the Standard Trawl

(Tables 14-17)

The trawling experiments carried out since 1956 according to the recommendation of the Baltic-Belt Seas Committee, were continued in 1959 with the R/V "Hermann Wattenberg" on various fishing grounds in the Kiel Bay on 27.—28. May, and 19.—23. October. The results concerning the length and age distribution of gadoid fish and flatfish are shown in Tables 14-17.

Table 13.

		Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.
Cod	1959	—	5	9	13	6	2	—	—	—
	1934-43	4	15	81	49	24	3	1	—	—
Plaice	1959	—	1	2	1	1	—	—	—	—
	1934-43	0.5	0.5	2	1	1	—	—	—	—
Flounder*and Dab	1959	—	—	—	1	33	24	12	4	1
	1934-43	—	—	8	23	35	35	18	3	—
Sprat	1959	—	—	—	—	—	—	—	—	—
	1934-43	—	—	—	—	—	22	60	60	5
Mackerel	1959	—	—	—	—	—	—	27	1	—
	1934-43	—	—	—	—	—	—	1.5	0.2	—

Table 13a.

Station	Depth m	Cod	Plaice	Flounder and Dab	Sprat	Mackerel
Winds Grav	35	36	3	14	—	53
S of Langeland	25	222	20	93	30	42
Boknis Eck	27	98	18	30	5	3

Table 14. Length distribution of cod, whiting, plaice, flounder, and dab taken with the standard trawl in the Kiel Bay, 27.-28. May 1959

Number per 1 hour's fishing

Length, cm	Cod	Whiting	Plaice	Flounder	Dab
< 5	530	—	—	—	—
6-10	1.7	0.7	—	—	2.7
11-15	27.0	4.3	—	—	5.0
16-20	17.0	2.7	—	—	19.6
21-25	8.3	0.3	3.3	0.3	12.3
26-30	1.7	—	2.3	0.3	3.0
31-35	1.0	—	0.7	—	1.7
36-40	—	—	—	—	—
41-45	—	—	—	—	—
46-50	0.7	—	—	—	—
51-55	0.3	—	—	—	—
56-60	—	—	—	—	—
> 60	1.0	—	—	—	—
Total number	588.7	7.3	6.3	0.6	44.3
Number examined	1500	22	19	2	133

Table 15. Age distribution of cod, whiting, plaice, flounder, and dab taken with the standard trawl in the Kiel Bay, 27.-28. May 1959

Number per 1 hour's fishing

Age-group	Cod	Whiting	Plaice	Flounder	Dab
0	530	—	—	—	—
I	55	7.0	—	—	3.3
II	1.3	0.3	5.0	—	22.0
III	1.0	—	1.3	0.6	13.3
IV	—	—	—	—	3.7
V +	1.0	—	—	—	2.0
Total	588.3	7.3	6.3	0.6	44.3

Table 16. Length distribution of cod, whiting, plaice, flounder, and dab caught with the standard trawl in the Kiel Bay, 19.-23. October 1959

Number per 1 hour's fishing

Length, cm	Cod	Whiting	Plaice	Flounder	Dab
6-10	17.5	9.3	—	—	11.8
11-15	12.0	19.9	0.1	—	103.9
16-20	5.5	7.0	0.8	—	63.6
21-25	15.9	4.5	0.7	—	36.4
26-30	6.8	2.0	1.6	0.1	10.9
31-35	1.8	0.1	4.6	0.5	1.2
36-40	0.6	—	3.8	0.1	0.2
41-45	1.2	—	0.6	—	—
46-50	0.5	—	0.2	—	—
51-55	0.2	—	—	—	—
56-60	0.2	—	—	—	—
> 60	0.1	—	—	—	—
Total number	62.3	42.8	12.4	0.7	228.0
Number examined	514	354	102	6	1,883

Table 17. Age distribution of cod, whiting, plaice, flounder, and dab caught with the standard trawl in the Kiel Bay, 19.-23. October 1959

Number per 1 hour's fishing

Age-group	Cod	Whiting	Plaice	Flounder	Dab
0	30.1	37.0	0.3	—	1.4
I	26.6	4.0	2.1	—	136.0
II	4.1	1.8	9.3	—	72.2
III	1.2	—	0.3	0.6	15.6
IV	0.1	—	0.3	0.1	1.8
V +	0.1	—	0.1	—	1.0
Total	62.3	42.8	12.4	0.7	228.0

For May the data are based on 3 hauls only because of the failure of the trawling at two stations due to tearing of the gear. For October, data are based on 11 hauls.

Cod

Already at the end of May, the 0-group (3—5 cm in length) was caught in large quantities especially S of Langeland (about 1000 in $\frac{1}{2}$ hour) and in the Vejsnæs Rinne (250 in 1 hour). Never before have so many small cod of the 0-group been caught so early in the year. Due to the high water temperatures in the spring, the 1959 year-class thrive very well as shown by hauls with the Petersen young-fish trawl carried out in the middle of May, yielding many young stages varying between 7 and 31 mm in length. In October, on the other hand, the 1959 year-class proved not to be so abundant as expected, its frequency being only a little higher than that of the preceding 1958 year-class. Both year-classes, as age-group 0 and I were less frequent than the corresponding year-classes in October 1958 (Ann. Biol., 15: 104). The future will show if the 1959 year-class is rich and whether this accordingly would be reflected on the cod fishery in the western Baltic. At present the stock of marketable cod is poor as may be seen from the low number of older age-groups.

Whiting

The catches of that species fluctuate heavily from year to year, and as we know from experience, in spring the number of whiting caught by trawl is much lower than in autumn (see Ann. Biol., 15: 123). This proved also to be the case in 1959. In October many fish of the 0- and I-group, and some older specimens were caught, but the total number was only half of that in October 1958 and 1956.

Plaice

The 1957 year-class dominated as II-group, 20—30 cm in length in May, and 22—36 cm in

October, with higher numbers than ever in the preceding years. Older and larger fish were scarce as usual. The 1958 year-class (I-group, 11—26 cm in length) was moderately represented in the catches in October.

Flounder

As this flatfish generally prefers shallow waters, and experimental fishing is practiced in the spring and autumn in deeper water, only a few flounders were caught.

Dab

Obviously the stock of this species, common in the western Baltic, has been replenished by the two rich 1957 and 1958 year-classes, and it was abundant in the October catches. Never before so many dabs were caught in an average haul, nearly threefold that in October 1958. As the majority of a year-class reaches marketable size in the course of the fourth year of life, good commercial catches are to be expected for 1960.

Long rough dab

As in the year before, a number of *Drepanopsetta platessoides* were caught. Except for a few older fish, the majority belonged to the I-group, measuring 11—18 cm in May (76 ind.), and 15—22 cm in October (62 ind.). The 1959 year-class was represented in October by some specimens, 6—9 cm in length.

Haddock

As the numerous appearance of small whiting and long rough dabs shows, the hydrographical conditions in the summer of 1959 seem to have favoured the invasion of fish from northern waters in the western Baltic. Whereas the haddock have become very rare in the western Baltic in the last decades, in October 1959 a number of small haddock were caught (10 in the Vejsnæs Rinne, 5 in the Hohwacht Bay). They belonged to the 1959 year-class and were 13—20 cm in length, except one specimen (27 cm) of the year-class 1958. In commercial hauls, some *Gadus esmarki* and *Gadus minutus* were found.

In the Eckernförder Bay the stagnation of water due to the hot and calm weather in the summer 1959, caused a progressive lack of oxygen in the bottom layer. As a result of this phenomenon the demersal fish avoided this area which under normal conditions is a good fishing ground. In October, 3 experimental hauls of 2½ hours' duration, yielded one plaice and nine whittings only. These catches were omitted when calculating the average catch per hour's fishing.

R. KÄNDLER

Danish Investigations of 0- and I-Group Flatfish in Coastal Waters and of Plaice and Flounder in the Open Sea in 1959

(Tables 18—19)

Plaice

As in 1957 and 1958, the Johansen young-plaice trawl operated at 1—2 m depth in the fishery for flatfish, was fitted with an iron chain at the footrope.

From Table 18 it is seen that the abundance of 1959 year-class plaice in the Belts and the western Baltic was about twice the normal strength, and in the western Baltic it was perhaps treble of the normal (too few stations). At Bornholm the strength was about normal.

I-group plaice occurred in relatively great quantities in the Belts and the western Baltic, corresponding to the many 0-group fish encountered at the coasts in 1958.

Flounder

Relatively great numbers of 0-group flounders were encountered in Køge Bay (the southern part of the Sound) and at the Baltic shores of Seeland and Møen. At Bornholm the numbers of 0-group fish seem to have been a little over normal. In the Belts and the western Baltic the occurrence of flounder is very varying because this fish prefers sheltered bays with mud-mixed bottom. Special investigation in such a water body at the Island Samsø in the northern Belts showed the presence of relatively many flounders.

Table 18. Numbers of 0- and I-group plaice, flounder, and turbot, and of 0-group brill caught per hour with the Johansen young-plaice trawl, and, at Bornholm, with the hand push-net (h.p.) in July/August 1959

Locality	Number of stations	Plaice		Flounder		Turbot		Brill
		0-gr.	I-gr.	0-gr.	I-gr.	0-gr.	I-gr.	
Belts	56	41 (28)	4 (3)	0.5	2	0	0	0.5
Sound	21	26 (17)	1 (2)	20	0	0	0	0
Western Baltic	4	49 (14)	2	1	0	0	0	0
W part of Baltic proper	7	0 (7)	0	27	20	0	0	2
Bornholm (h.p.)	12	16 (17)	4	242 (231)	4	81 (25)	22	0

Table 19. Danish catch of plaice per hour in hauls with the standard trawl in 1959

Month	Depth, m	Number of stations	Centimetre groups									Total
			6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	
<i>Northern Belts and Great Belt</i>												
June-Aug.	6-14	4	0.5	3	14	24	6	—	—	—	—	48
	15-24	9	0.2	6	28	58	9	2	0.2	—	—	103
	25-34	3	—	—	3	13	6	4	—	—	—	26
	35-42	4	—	—	0.5	—	8	4	4	—	—	16
Oct.—Dec.	6-14	10	27	43	19	24	3	—	—	—	—	116
	15-24	13	1	2	7	19	12	2	0.2	—	—	43
	25-34	3	5	—	1	3	7	2	—	—	—	13
<i>Little Belt</i>												
June—Sept.	6-14	5	3	2	8	11	1	—	—	—	—	25
	15-24	18	10	4	12	16	1	1	0.2	—	—	34
	25-34	9	—	—	0.4	1	1	1	—	—	—	3
	35-43	4	—	—	—	—	2	2	—	—	—	4
December	6-14	5	1	4	19	3	3	1	—	—	—	31
	15-24	18	—	—	—	2	3	3	1	—	—	9
	25-34	9	—	—	—	5	6	9	—	0.4	—	20
	35-45	4	—	—	—	4	7	7	2	—	—	20
<i>Western Baltic</i>												
Aug.—Sept.	15-24	8	—	—	—	2	4	1	—	—	—	7
	25-34	4	—	—	—	2	4	—	0.5	—	—	6
<i>The Sound</i>												
September	21-24	2	—	—	—	—	—	3	2	—	—	5
	25-30	6	—	—	—	—	6	9	9	2	—	26
<i>At Bornholm</i>												
August	35-75	13	—	—	0.2	7	3	1	2	1	0.2	14

Turbot, brill, and sole

Young turbot were as usual very scarcely represented, except at Bornholm where they occurred in more than normal abundance. Relatively many 0-group brill were found in the northern Belts. The preliminary discrimination between turbot and brill has not been revised. In Køge Bay the frequency of I-group brill was much greater than normal. In 1958, 0-group brill was encountered especially in the southern Kattegat.

In Køge Bay 0-group sole occurred in relatively great quantities (about three specimens per 60 min. haul).

Plaice in the open sea

From the length distributions shown in Table 19 it is seen that the I- and II-groups were predominant in the catches taken from the R/V "Biologen" in the Belts. Both of these year-classes, 1958 and 1957, were stronger than normal according to the investigations of 0-group fish in these years, especially the 1958 year-class. From otolith readings most of the plaice have been determined as II-group fish but according to their length most of them were expected to be I-group fish. The greatest density of the stock was found in the Great Belt between south-western Fyn and northern Langeland where 395 plaice were taken in one haul; it is perhaps possible that growth actually can be suppressed so much in such a local accumulation that it becomes

similar to that encountered in the beginning of the century before the more intensive fishery began. Another possibility is that a false ring has been found on some of the otoliths.

It is very interesting to note that the average density of fish of all lengths was on the whole twice that of 1958, due especially to recruitment to the stock of the rich 1958 year-class from outside the 6 m depth contour.

In the western Baltic the hauls carried out at depths below 15 m were too few for estimating a change in numbers, in other depth zones the density was similar for the two years.

In the Sound the plaice occurred mostly at 25 m depth and over, whereas in 1958 plaice were found only in a single haul made at about 24 m depth. The largest and oldest fish belonging to group VII and older constituted two-fifths of the stock in 1958 but had disappeared in 1959, and the majority of the plaice caught belonged to age-groups III and IV (1955 and 1956 year-classes, which were of about normal strength).

At Bornholm the density of the stock outside the 35 m contour was more than twice that of 1958. On account of the greater oxygen content in the deeper water layers many plaice had left the shallower depths. In 1958 the majority of the plaice belonged to the 1955 and 1956 year-classes, in 1959 the rich 1957 year-classes provided the largest numbers.

AAGE J. C. JENSEN

Table 20. Length and weight of plaice caught in Gdansk Bay

Sex		♂			♀		♂ + ♀
	Number of fish	%	Mean weight	Number of fish	%	Mean weight	%
Length, cm							
18	8	4.7	75.0	9	5.3	71.1	10.0
19	13	7.6	80.8	19	11.0	75.5	18.6
20	24	14.0	92.5	12	7.0	91.3	21.0
21	14	8.2	109.6	17	9.9	104.7	18.1
22	12	7.0	120.0	12	7.0	119.2	14.0
23	5	2.9	140.0	7	4.1	140.7	7.0
24	2	1.2	152.5	7	4.1	155.0	5.3
25	1	0.6	180.0	2	1.2	172.5	1.8
26	—	—	—	1	0.6	240.0	0.6
27	—	—	—	—	—	—	—
28	—	—	—	—	—	—	—
29	—	—	—	1	0.6	240.0	0.6
30	1	0.6	290.0	—	—	—	0.6
31	1	0.6	280.0	—	—	—	0.6
32	—	—	—	—	—	—	—
33	—	—	—	—	—	—	—
34	—	—	—	—	—	—	—
35	—	—	—	—	—	—	—
36	—	—	—	1	0.6	580.0	0.6
37	—	—	—	—	—	—	—
38	—	—	—	—	—	—	—
39	—	—	—	—	—	—	—
40	—	—	—	—	—	—	—
41	—	—	—	1	0.6	630.0	0.6
42	—	—	—	1	0.6	670.0	0.6
Total	81			90			171
%	47.4			52.6			100.0
Mean length, cm	20.7			21.5			21.1

Table 21. Length and weight of the plaice from the Bornholm Basin

Sex		♂			♀		♂ + ♀
	Number of fish	%	Mean weight	Number of fish	%	Mean weight	%
Length, cm							
21	13	4.6	99.2	—	—	—	4.6
22	8	2.8	104.3	—	—	—	2.8
23	3	1.0	128.3	1	0.3	140.0	1.3
24	4	1.4	148.8	2	0.7	150.0	2.1
25	3	1.0	175.0	13	4.6	185.3	5.6
26	7	2.4	189.3	1	0.3	190.0	2.7
27	10	3.5	203.0	11	3.8	210.9	7.3
28	4	1.4	218.7	26	9.1	245.7	10.5
29	3	1.0	260.0	15	5.2	264.0	6.2
30	11	3.8	267.7	22	7.6	308.4	11.4
31	4	1.4	290.0	13	4.6	329.6	6.0
32	4	1.4	365.0	11	3.8	351.3	5.2
33	3	1.0	346.6	8	2.8	405.6	3.8
34	2	0.7	335.0	14	4.9	407.1	5.6
35	2	0.7	422.5	23	8.0	459.3	8.7
36	—	—	—	13	4.6	498.4	4.6
37	—	—	—	7	2.4	517.8	2.4
38	—	—	—	5	1.7	552.0	1.7
39	—	—	—	5	1.7	588.0	1.7
40	—	—	—	6	2.1	674.2	2.1
41	—	—	—	2	0.7	650.0	0.7
42	—	—	—	2	0.7	740.0	0.7
43	—	—	—	2	0.7	917.2	0.7
44	—	—	—	1	0.3	725.0	0.3
45	—	—	—	3	1.0	803.3	1.0
46	—	—	—	1	0.3	880.0	0.3
Total	81			207			288
%	28.1			71.9			100.0
Mean length, cm	26.7			32.2			30.7

Table 22. Age composition of the plaice catches in 1959 and 1957-58

Age-groups	(in %)							Total
	II	III	IV	V	VI	VII	VIII+	
Gdansk Bay								
♂	—	41.5	4.7	—	1.2	—	—	47.4
♀	10.5	28.6	11.1	0.6	—	0.6	1.2	52.6
♂ + ♀	10.5	70.1	15.8	0.6	1.2	0.6	1.2	100.0
♂ + ♀ in 1957-1958	21.2	44.1	17.1	12.1	3.2	1.5	0.8	100.0
Bornholm Basin								
♂	—	6.9	8.3	7.3	2.8	2.8	—	28.1
♀	—	1.0	11.1	21.9	8.0	18.4	11.5	71.9
♂ + ♀	—	7.9	19.4	29.2	10.8	21.2	11.5	100.0
♂ × ♀ in 1957-1958 ...	0.2	7.1	27.2	23.3	17.2	10.8	14.2	100.0

Length and Age Composition of the Polish Plaice Catches in the Southern Baltic during 1959

(Tables 20-22)

The results of length and weight analyses of the Polish plaice catches in Gdansk Bay and the Bornholm Basin are given in Tables 20 and 21. From these tables it may be seen that the catches taken in the Gdansk region contained plaice ranging in length between 18 and 42 cm (mean length, 21.1 cm), whereas those taken in the Bornholm Basin ranged between 21 and 46 cm (mean length, 30.7).

The age composition of the catches made in 1959, together with a comparison with the data for 1957/58 is presented in Table 22.

In Gdansk Bay a decrease was observed in 1959 in the proportion of fish belonging to age-groups II, IV, and VI, together with a simultaneous increase of age-group III.

In the Bornholm Basin a decrease was observed in age-groups IV and VI, whereas groups V and VII showed a distinct increase.

Z. REIMANN

Table 23. Length and age composition of flounder catches in the Gdansk Basin during 1959

Length, cm	Age-groups							Total	%
	II	III	IV	V	VI	VII	VIII		
18	9	3	—	—	—	—	—	12	0.5
19	37	11	—	—	—	—	—	48	2.2
20	52	55	—	—	—	—	—	107	4.9
21	86	90	5	—	—	—	—	181	8.3
22	99	125	6	—	—	—	—	230	10.5
23	54	146	38	—	—	—	—	238	10.9
24	24	170	43	—	—	—	—	237	10.8
25	17	202	46	—	—	—	—	265	12.1
26	2	149	65	4	—	—	—	220	10.0
27	—	92	90	2	—	—	—	184	8.4
28	—	35	87	13	—	—	—	135	6.2
29	—	6	55	34	1	—	—	96	4.4
30	—	—	58	25	3	—	—	86	3.9
31	—	—	19	27	5	—	—	51	2.3
32	—	—	6	19	9	—	—	34	1.5
33	—	—	2	12	9	—	—	23	1.1
34	—	—	—	2	10	1	—	13	0.6
35	—	—	—	3	6	5	—	14	0.6
36	—	—	—	—	2	2	—	4	0.2
37	—	—	—	—	1	—	—	1	0.1
38	—	—	—	—	—	3	1	4	0.2
39	—	—	—	—	—	2	—	2	0.1
40	—	—	—	—	—	2	1	3	0.1
41	—	—	—	—	—	—	1	1	0.1
42	—	—	—	—	—	—	1	1	
—	—	—	—	—	—	—	—	—	
44	—	—	—	—	—	—	1	1	
Total	380	1084	520	141	46	15	5	2191	
%	17.3	49.5	23.7	6.5	2.1	0.7	0.2	100.0	100.0
Average length	22.5	23.9	26.8	30.3	33.0	36.8	—	25.0	

Table 24. Age composition of the flounder catches in Gdansk Bay during the period 1957/59 (%)

Year	Number of fish	Age-groups							Total
		II	III	IV	V	VI	VII	VIII+	
1957	2,862	14.0	39.7	33.8	9.7	2.1	0.6	0.1	100.0
1958	2,172	21.9	39.6	29.0	7.8	1.3	0.3	0.1	100.0
1959	2,191	17.3	49.5	23.7	6.5	2.1	0.7	0.2	100.0

Flounder Investigations in Gdansk Bay in 1959

(Tables 23-25)

After a distinct drop in the Polish flatfish catches during the period 1955/58, the year 1959 showed an increase in these catches. The total landings of flatfish during 1959 amounted to 1,403 tons in comparison with 948 in 1958. This rise in the total catch was due to increasing fishing effort and to higher yields of the catches. According to data by H. JANKO the average yield per one cutter per day was 6.5 kg in 1959 in comparison with 4.5 kg obtained in 1958.

The percentage composition of the catch by different species in 1959 was as follows:—

	Flounder	Plaice	Dab	Turbot
Pomeranian Bay ..	24.0	76.0	—	—
Bornholm Basin ..	67.3	31.8	0.4	0.5
Gdansk Bay	85.0	13.1	—	1.9

The results of length and age analyses of the flounder catches in Gdansk Bay during 1959 are given in Table 23, and comparison of the 1959 age and length compositions with those for 1957 and 1958 are given in Tables 24 and 25.

When comparing the age composition of the flounder catches in 1959 with that observed in previous years, the increase in the proportion of fish belonging to age-group III, together with a certain decrease in age-groups II, IV, and V is noticeable. The catches consist mainly of young fish belonging to age-groups II—IV. The proportion of these groups is 90.5%.

Table 25. Average length distribution of flounder from Gdansk Bay during the period 1957/59 (cm)

Year	Age-groups					
	II	III	IV	V	VI	VII
1957	20.6	23.2	25.5	28.5	31.6	34.0
1958	20.8	23.9	26.9	29.7	32.4	35.7
1959	22.5	23.9	26.8	30.3	33.0	36.8

The average length of the flounder caught in Gdansk Bay in 1959 is a little higher than in 1958 (1959: 25.0 cm; 1958: 24.7 cm). The average lengths calculated for each age-group for the period 1957 to 1959 are given in Table 25.

W. CIEGLEWICZ

Eel

Danish Investigations on Eel

On the basis of the summer temperatures of the surface water, forecasts of the yield of the silver-eel fishery in the Limfjord, the Belt Sea, and the Baltic were given. The summer temperature was very high and about twice the normal yield of this fishery was predicted; on the whole, this forecast held good.

The tumour disease occurred at the coasts in about 1% of the eels, that is, approximately the same frequency as in previous years. In 1959 some few eels with the tumour disease were also found in fresh water.

AA. J. C. JENSEN

Gadoid Fish

INTRODUCTION

Contributions to this report have been received from the following:—

Denmark:

AA. J. C. JENSEN
J. S. JOENSEN
P. M. HANSEN

Germany:

ARNO MEYER
D. SAHRHAGE

Iceland:

JÓN JÓNSSON

Norway:

E. BRATBERG

Poland:

ST. RUTKOWICZ

Scotland:

R. JONES
R. GAMBLE

U.S.S.R:

A. S. BARANENKOVA
I. A. LABLAIKA
M. A. SONINA

ULRICH SCHMIDT

YOUNG STAGES

Greenland

Cod Fry and Small Cod in Coastal Waters and on the Offshore Banks of West Greenland in 1959

(Figures 1-3; Tables 1-2)

Occurrence of eggs and larvae

The catches of cod eggs in 1 m stramin net, in 30 min. hauls with 100—50 m of wire out in the Godthåb fjord area were much smaller than in previous years. The highest number caught was 1,973 eggs, taken on 4. April on a spawning ground near Kapisigdlit in the innermost part of the fjord.

On 10. May, 1,036 and on 13. May, 1,133 eggs were taken at two other stations in the fjord. On no other station did the number of eggs exceed 100.

Three hauls with a 1 m stramin net were made in the Davis Strait on 5. June. A haul between the coast and Fylla Bank yielded 7 eggs, a haul on the bank none, and a haul on the western slope of the bank yielded 93 eggs. In addition, one cod larva was caught at the first station and 7 at the last, but none at the station on the bank. As the cod spawn on the western slope it is only natural that the largest catches of eggs and larvae were made there.

The numbers of cod eggs and larvae caught with stramin net by "Dana" in July are shown in Figure 1. For the first time during the nine years "Dana" has made investigations in Davis Strait in July,

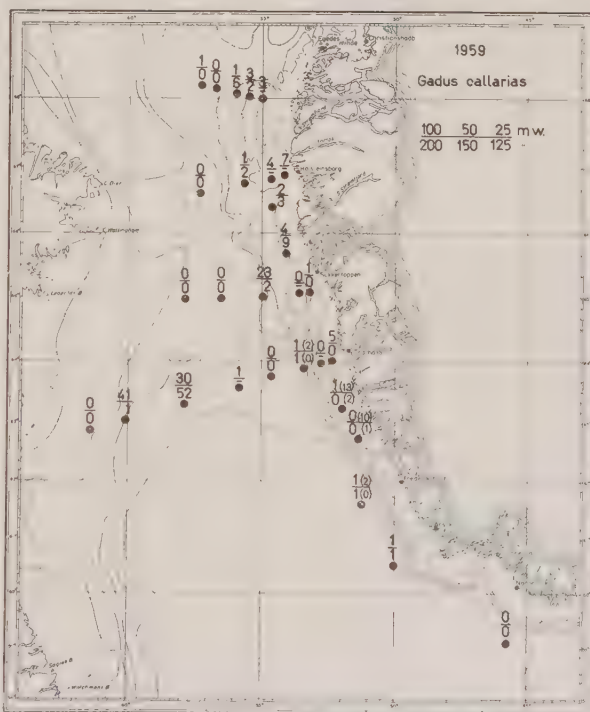


Figure 1. Catches of cod larvae taken in 30 min. haul with a 2 m stramin net.

Table 1. Small cod, age-groups I, II, and III

Sample	Position		Date	Number of fish	Gear
	N	W			
a	70°40'	52°00'	22 July	705	hand-seine
b	69°05'	51°00'	29 July	889	hand-seine
c	68°50'	51°05'	30 July	870	hand-seine
d	67°57'	53°35'	2 July	1019	hand-seine
e	66°55'	53°35'	1 July	1156	hand-seine
f	66°44'	53°28'	26 June	961	hand-seine
g	63°53'	51°28'	18 Jan.	1224	shrimp-trawl
h	63°53'	51°28'	3 March	1429	shrimp-trawl
i	Utorqarmiut		3 March	386	shrimp-trawl
j	63°53'	51°28'	24 March	572	shrimp-trawl
k	Utorqarmiut		24 March	329	shrimp-trawl
l	Utorqarmiut		23 Nov.	153	shrimp-trawl
m	63°53'	51°28'	24 Nov.	114	shrimp-trawl
n	63°53'	51°28'	21 Dec.	108	shrimp-trawl
o	60°56'	45°47'	18 Feb.	337	shrimp-trawl
p	60°34'	45°55'	30 July	969	hand-seine
q	60°34'	45°55'	30 July	152	pound-net

eggs were observed in the hauls. In Figure 1 the number of eggs are given in brackets. A total of 30 eggs were taken in six hauls from four different stations. These captures of eggs indicate a retarded hatching in 1959.

The distribution and frequency of cod larvae did not differ much from the year 1958. The largest numbers were observed west of Fylla Bank (63°18'N, 57°47'W). On the westernmost station of the section across Fylla Bank (62°52'N, 61°18'W), close to the edge of the ice covering the western part of the Strait, no larvae were caught.

The scarce occurrence of eggs and larvae of cod indicate that the 1959 year-class will become a poor year-class of small importance for the commercial fishery.

Occurrence of age-groups I, II, and III

Small cod occurred in large quantities along the coast. Good catches were made with fine-meshed seine near the beach and with shrimp trawl in 200–250 m depth. A summary of the catches is presented in Table 1, and the length distribution of the different catches in Figure 2. A total of 11,373 small cod from 17 catches were measured, and 1,582 otoliths were examined from 15 of these catches.

It is apparent from the length distribution that one age-group, the II-group (1957 year-class), is strongly predominant in most of the catches. This was to be expected as the 1957 year-class occurred numerously along the coast of the Godthåb (ID) (see Fig. 3) and Holsteinsborg (IB) districts in 1958. In the samples a—h and in j, it is almost the only year-class present. Samples g—n are from shrimp trawl at two neighbouring localities in the Godthåb district (ID). In six of these samples the II-group

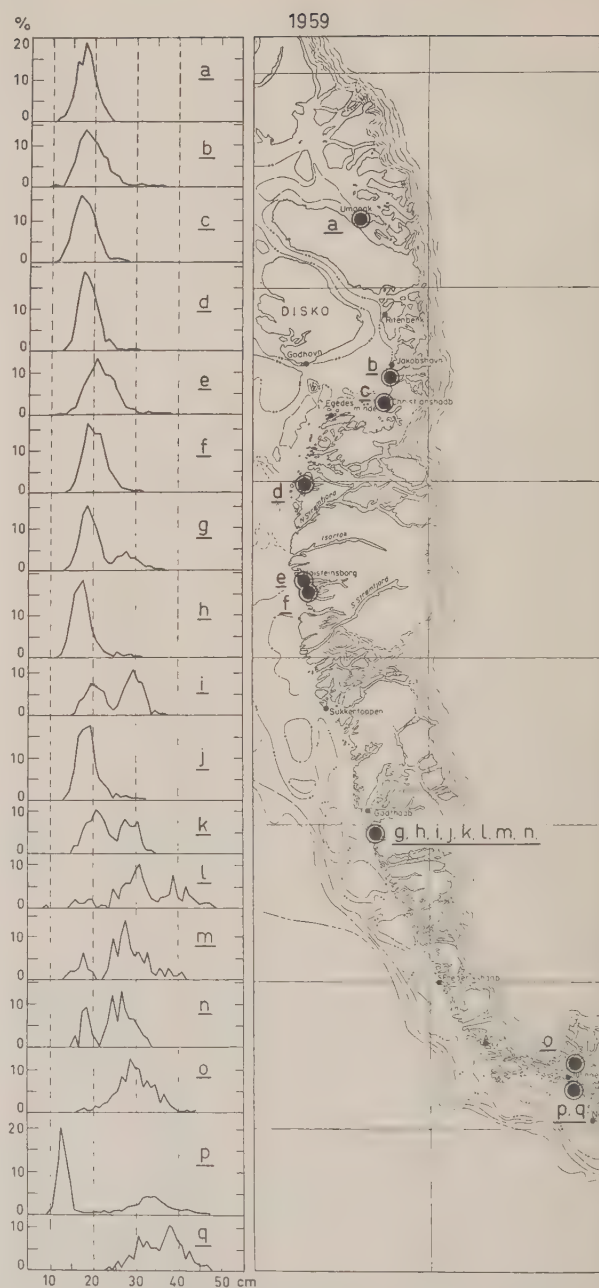


Figure 2. Length distribution of small cod in coastal areas.

predominates, in the two remaining, i and k, the III-group. From the length distribution it might appear as if the III-group dominated in l and m. However, the age determinations show that the II-group is the predominant one. The reasons for the great difference in the length distribution of the II-group in samples g—k and l—n is due to

Table 2. Mean lengths (cm) of small cod of age-groups I, II, and III

(See Figure 2 and Table 1)

Age-group	Samples														
	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
I	—	—	—	—	—	—	—	—	—	—	—	17.2	17.4	18.6	—
II	19.4	19.9	18.8	21.0	23.3	19.8	19.1	19.0	20.4	19.3	20.7	29.7	28.5	27.5	19.6
III	—	30.3	—	—	32.4	—	28.5	28.7	29.6	27.1	28.6	39.7	38.0	—	31.6

the fact that the g—k samples are taken in January/ March, while the l—n samples are from November/ December. Between the two sets is an interval of 7—8 months, and in that time the individuals of the II-group have grown 7—10 cm.

Samples o, p, and q are taken in subdivision 1F with shrimp trawl, fine-meshed seine, and pound net respectively; p and q are from the same locality and time, but they are highly different in length distribution as the seine easily retains the small fish, while such small fish easily escape through the meshes of the pound net. Samples o and q include exclusively the III-group (1956 year-class), apart from very few specimens of the IV-group. In p the I- and III-groups are almost equally represented. All the three samples from 1F differ from the samples taken in the other subdivisions in so far as the II-group (1957 year-class) is absent.

The rich occurrence of the 1957 year-class in the catches of small cod (I—III groups) confirms the assumption cited in 1958 (see Ann. Biol., 15: 86), that this year-class is to be considered a rich one which in the future will be of importance to the West Greenland fishery. Table 2 presents the average lengths of cod of age-groups I—III in the samples a—o.

P. M. HANSEN

Small Cod of Age-Groups 0, I, II, and III in the Barents Sea

(Tables 3–5)

A quantitative analysis of small cod was carried out during the winter of 1958/59 from the R/V "Tunetz". As in previous years this analysis was carried out with a covered cod-end. The results are shown in Table 3. Small cod of the 1956 and 1958 year-classes were predominant in the catches. Cod belonging to the 0-group (1958 year-class) caught in the Central Elevation area were encountered in greater numbers than in the other fishing areas; they were less abundant in the central and south-eastern areas. Young cod of the 1956 year-class were more numerous in the western and central areas. The 1957 year-class occurred in



Figure 3. Subdivisions of West Greenland waters according to those used by the International Commission for the Northwest Atlantic Fisheries.

small numbers in the same areas, but it was more abundant both in the central area and the Central Elevation area; the average catch per hour's trawling was 7 fish. In the preceding year this year-class yielded 93 fish per hour's trawling in the Central Elevation area and 41 in the western area. From

Table 3. Mean number of young cod of different ages caught per hour's trawling in the southern part of the Barents Sea

Areas	Number of trawlings	Age and year-class				Total	Total number of fish
		0 + (1) 1958	1 + (2) 1957	2 + (3) 1956	3 + (4)* 1955		
Central	65	12	7	11	2	32	2,073
Western	69	9	2	13	3	27	1,931
Coastal	16	5	1	3	<1	10	161
Eastern	15	13	2	1	<1	17	254
Central Elevation	21	16	7	5	<1	28	598
Total	186	11	4	9	2	26	5,017
⁰ / ₁₀₀ of the total		39.8	16.3	36.2	7.7		

* This group includes only specimens below 36 cm in length.

Table 4. Mean number of 0-group cod of the different year-classes caught during the winter in the southern part of the Barents Sea

Year-classes	Central Elevation area	Central area	Western area	Coastal area	Eastern area
1950	14	15	6	12	19
1951	?	18	?	11	3
1952	6	2	1	1	1
1953	15	2	2	5	14
1954	61	44	4	10	32
1955	9	4	4	14	13
1956	5	16	5	19	13
1957	93	25	41	6	1
1958	16	12	9	5	13

comparison with the indices obtained for the 0-group of other year-classes (see Table 4) it appears that small cod of the 1957 year-class was distributed farther westwards than the I-group of other year-classes have been. The 1958 year-class also occurred farther westwards in comparison with previous 0-groups. This distribution conforms with the hydrological features of the Barents Sea in 1957 and 1958. During these years the waters of the northern branch of the North Cape Current were relatively warmer than the waters of the Murman branch.

Table 5. Mean number of 1—4 year-old cod of the different year-classes caught per hour's trawling in the southern part of the Barents Sea during the winter

Year-class	Mean catch of 2 and 3 year-olds			
	1 year- old	2 year- old	3 year- old	4 year- old
1946 ...	<1	2	7	8
1947 ...	2	8	23	5
1948 ...	18	28	21	31
1949 ...	5	14	34	26
1950 ...	14	89	77	70
1951 ...	16	20	8	3
1952 ...	1	1	3	2
1953 ...	4	11	11	4
1954 ...	30	14	6	15
1955 ...	7	1	9	2
1956 ...	12	15	9	—
1957 ...	31	4	—	—
1958 ...	11	—	—	—

Table 5 shows the mean catches for the whole Barents Sea of young cod of different year-classes at different ages. These figures show that the numbers of cod of the 1956 year-class are average compared with other year-classes; the number of 2 year-old fish (1957 year-class) are moderate. The 1958 year-class occurs also in moderate numbers in view of its wide distribution.

A. S. BARANENKOVA

COMMERCIAL FISH

COD

Greenland Stock

Cod Investigations in the Coastal Waters and on the
Offshore Banks of West Greenland in 1959

(Figures 4-5; Tables 6-7)

1. The age composition

(a) Offshore banks

Otoliths of 974 cod were collected from the banks; 94 are from long-lines, "Adolf Jensen", Fylla Bank, 5. June, and 880 are from hand-lines, "Dana", 23. July/2. August. Table 6 and Figure 4 present age and length distributions by 5 cm groups.

It is to be noted that otoliths for age determination were taken from those cod in the catches which due to damage were not suited for tagging. As small cod are most apt to be hurt these will appear in the age determination samples with too high percentages compared to the larger fish. This is especially the case in sections 4 and 5 in Figure 4 where the length distribution curves, including measurements of both tagged and aged cod, show a higher frequency of larger cod than expected from the age analyses. For the remaining samples this is of no importance.

The 1953 year-class predominates in five of the catches, the 1955 year-class in three; the 1947 year-class is predominant in the long-line catches from the edge of Fylla Bank on 5. June.

Mainly smaller and middle-sized cod are present in the catches from Store Hellefiske Bank (1B, p. 115) which almost exclusively consist of cod of the 1953 year-class or younger.

The catches from Lille Hellefiske Bank and Banana Bank include small as well as large cod, as they besides the 1953 and younger year-classes also consist of some older cod, especially of the 1947 and 1950 year-classes. In the age analyses of these catches, however, the older 1950 and 1947 year-classes are, as already mentioned, too weakly represented. The catches from Fylla Bank and Fiskenes Bank (1D) include in the main larger cod, as hardly any cod younger than the 1953 year-class were caught.

In 1959, the 1953 year-class was without doubt the most important one for the fishery in the entire Davis Strait. The older, rich 1947 and 1950 year-classes appear to have been more numerous on the more southern banks than on Store Hellefiske Bank, but both these year-classes are now strongly reduced in number.

(b) Inshore waters and fjords

From the coastal area and the fjords 5,403 cod from 31 catches were aged. Age analyses and localities are presented in Table 7 and Figure 5. The catches are distributed through the ICNAF subdivisions (see p. 115) as follows:—

1A	1B	1C	1D	1E	1F
3	2	5	10	3	8

Of the ten catches taken in 1D five are from the Godthåb fjord.

Samples Nos. 1 and 2 are from 1A. The 1947 year-class predominates in No. 1 with 25%. The older 1945 and 1942 year-classes both yield 11%. The older year-classes have always accounted for a considerable portion of the catches at this northern locality. The 1942 year-class was predominant in all samples taken in the period 1951 to 1958. The 1953 year-class predominates in No. 2 with more than 35%; 1947 accounts for 20%, while all other year-classes are below 10%.

The three samples (Nos. 3, 4, and 5) from 1B are dominated completely by the 1953 year-class with 60–65%.

In 1C the 1953 year-class predominates in four of the five samples (Nos. 6, 7, 8, 9, and 10); in No. 6 it makes up more than 65%. The 1947 and 1950 year-classes are more numerously represented in this subdivision than in 1B. In No. 8 the 1947 year-class predominates, while the 1950 year-class holds the second place.

In subdivision 1D, samples Nos. 11–15 are from the mouth of Godthåb fjord, and Nos. 16–20 are from the fjord proper. The samples from the mouth of the fjord are taken on long-line, except No. 11 which was taken on hand-line. The 1953 year-class predominates in No. 11 with the 1956-class as second; the remaining year-classes are not important. The other four samples (Nos. 12–15), long-line catches taken in deep water, are more uniform as to age composition. The 1947 year-class is predominant in all of them. The five samples from Godthåb fjord present a rather differing composition. The two long-line catches (Nos. 16 and 18) are from deep water (about 300 m) and are rather homogeneous with the 1947 year-class predominating. No. 17, taken on hand-line and No. 19 on long-lines at only 50–100 m depth, include — contrary to Nos. 16 and 18 — mainly small fish. In No. 17 the following year-classes, mentioned in

Table 6. Age composition of the cod on West Greenland banks in 1959, together with the mean lengths of males and females at each age

Year-class	Age-group	Sample Nos.			Sample Nos.			Sample Nos.		
		1			2			3		
		Store Hellefiske Bank 67°54'N, 55°10'W 25 July, 45—50 m Hand-line cm			Store Hellefiske Bank 66°54'N, 54°22'W 26 July, 82 m Hand-line cm			Store Hellefiske Bank 66°50'N, 54°40'W 23 July, 45—51 m Hand-line cm		
		No.	♂♂	♀♀	No.	♂♂	♀♀	No.	♂♂	♀♀
1956	III	3	43.0	43.0	3	41.7	—	1	38.0	—
1955	IV	12	46.3	48.3	38	48.6	49.5	30	50.4	—
1954	V	12	57.3	53.0	54	57.8	58.9	22	57.7	—
1953	VI	20	62.3	63.5	109	65.1	66.7	22	61.7	—
1952	VII	1	75.0	—	6	68.5	70.0	1	71.0	—
1951	VIII	—	—	—	7	74.3	79.7	—	—	—
1950	IX	—	—	—	12	78.4	81.5	—	—	—
1948	XI	—	—	—	1	77.0	—	—	—	—
1947	XII	—	—	—	5	82.0	84.0	—	—	—
Total number		48			235			76		

Year-class	Age-group	Sample Nos.			Sample Nos.			Sample Nos.		
		4			5			6		
		Lille Hellefiske Bank 64°56'N, 53°19'W 29 July, 36—85 m Hand-line cm			Banana Bank 64°21'N, 53°20'W 30 July, 67—80 m Hand-line cm			Fylla Bank 64°05'N, 52°44'W 31 July, 42—52 m Hand-line cm		
		No.	♂♂	♀♀	No.	♂♂	♀♀	No.	♂♂	♀♀
1956	III	14	39.3	39.1	12	38.0	38.9	7	41.8	42.0
1955	IV	18	44.5	44.8	25	47.5	47.4	7	48.5	49.7
1954	V	4	57.5	53.5	11	59.2	55.6	24	58.7	58.9
1953	VI	13	68.0	65.8	14	69.3	65.3	86	66.2	68.6
1952	VII	3	70.5	73.0	2	72.5	—	14	73.6	71.4
1951	VIII	4	72.0	85.0	3	73.0	72.0	12	73.6	78.6
1950	IX	6	80.0	80.0	6	76.0	77.5	17	75.3	79.3
1949	X	—	—	—	1	60.0	—	3	79.0	85.0
1948	XI	2	78.5	—	3	—	86.7	1	80.0	—
1947	XII	6	78.5	79.0	12	79.1	84.0	12	83.6	81.3
1946	XIII	—	—	—	1	81.0	—	—	—	—
1945	XIV	1	80.0	—	2	80.0	87.0	5	86.8	83.0
1942	XVII	—	—	—	—	—	—	1	85.0	—
Total number		71			92			189		

Year-class	Age-group	Sample Nos.			Sample Nos.			Sample Nos.		
		7			8			9		
		Fylla Bank 63°53'N, 53°28'W 5 June, 80—240 m Long-line cm			Fylla Bank 63°37'N, 52°40'W 1 August, 67 m Hand-line cm			Fiskenæs Bank 63°25'N, 52°04'W 2 August, 60—70 m Hand-line cm		
		No.	♂♂	♀♀	No.	♂♂	♀♀	No.	♂♂	♀♀
1956	III	—	—	—	—	—	—	1	—	36.0
1955	IV	—	—	—	—	—	—	3	53.0	51.5
1954	V	1	68.0	—	3	59.0	54.0	—	—	—
1953	VI	14	63.6	67.1	18	66.9	66.8	22	66.3	64.0
1952	VII	4	—	76.3	10	71.5	71.7	21	70.5	69.8
1951	VIII	6	71.0	75.0	3	70.7	—	19	74.3	75.2
1950	IX	26	76.5	78.5	8	72.3	77.4	19	76.9	77.8
1949	X	1	82.0	—	4	86.0	81.3	1	76.0	—
1948	XI	3	—	85.7	3	77.0	—	3	87.0	79.0
1947	XII	31	77.6	82.8	6	77.3	80.0	12	79.9	80.8
1946	XIII	—	—	—	2	79.0	81.0	3	83.5	85.0
1945	XIV	2	80.0	95.0	3	79.0	82.5	2	76.0	94.0
1942	XVII	6	90.0	92.7	—	—	—	2	88.5	—
Total number		94			60			108		

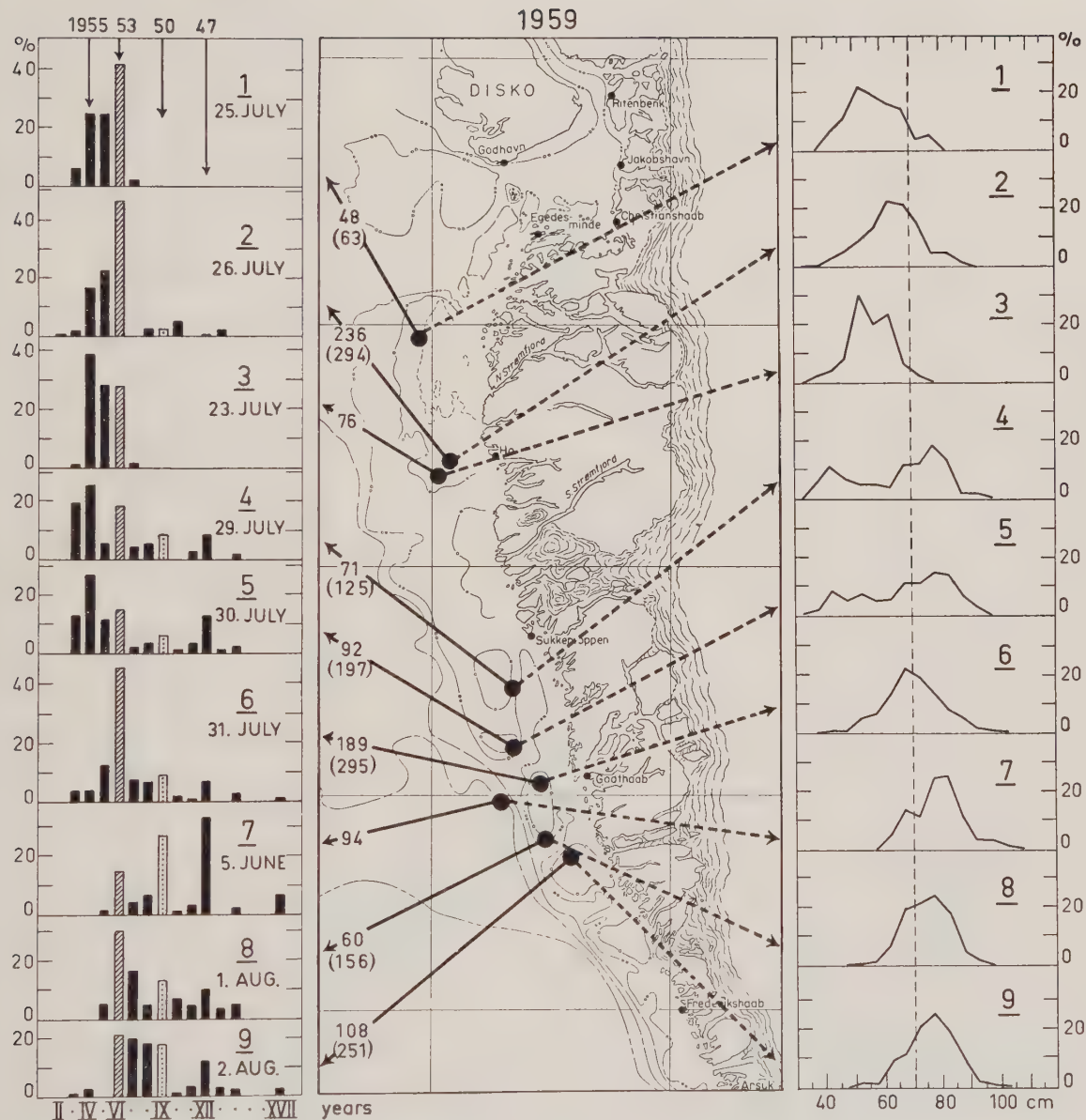


Figure 4. Percentage age and length distribution of cod from West Greenland banks. The numbers of cod examined and tagged (shown in brackets) are shown on the map.

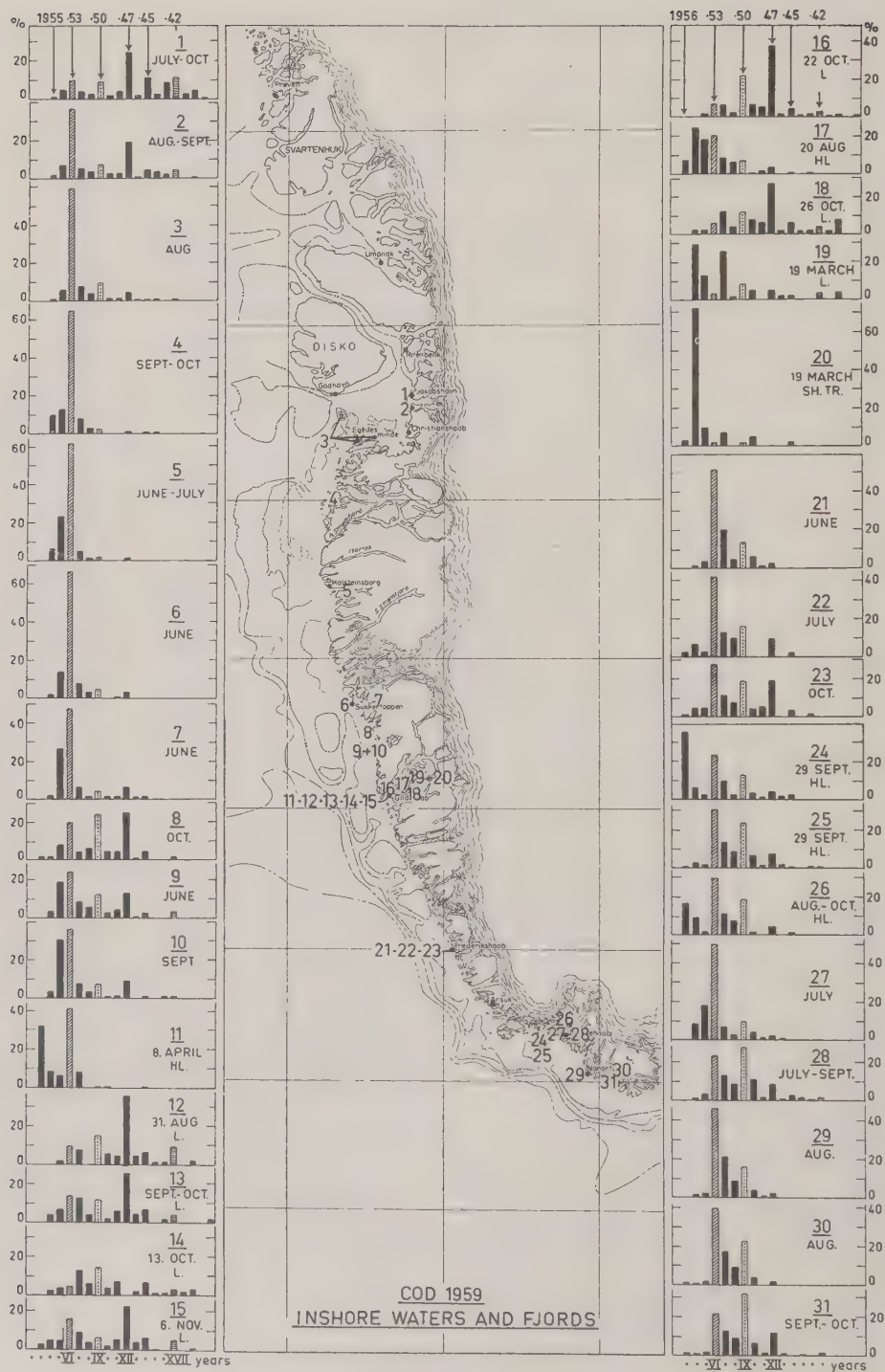


Figure 5. Percentage age distribution of cod from coastal areas.

Table 7. Age composition from inshore waters and fjords of West Greenland in 1959

Sample Nos.		1	2	3	4	5	6	7	8	9	10	11
Year-class	Age-group	July Aug. Sept. Oct.	Aug. Sept.	Aug.	Sept. Oct.	June July	June	June	Oct.	June	Sept.	April
1956	 III	—	—	—	I	—	—	—	2	6	—	34
1955	 IV	I	4	4	19	12	3	2	2	6	6	9
1954	 V	6	17	24	24	46	26	41	15	38	62	7
1953	 VI	13	90	278	127	121	133	74	38	47	73	44
1952	 VII	5	12	60	15	10	15	10	8	17	15	9
1951	 VIII	3	8	18	4	2	6	2	11	11	6	—
1950	 IX	12	18	46	4	4	9	7	46	24	15	I
1949	 X	2	5	4	—	—	—	2	8	5	I	I
1948	 XI	5	6	6	—	—	I	2	8	8	2	—
1947	 XII	33	47	19	I	3	6	10	49	25	18	—
1946	 XIII	2	2	2	—	—	—	2	I	I	—	—
1945	 XIV	15	10	2	I	—	—	2	8	4	I	I
1944	 XV	3	9	I	I	—	—	—	—	—	—	—
1943	 XVI	11	5	—	—	—	—	—	—	—	I	—
1942	 XVII	15	11	I	—	—	—	—	2	6	I	—
1941	 XVIII	3	—	—	—	—	—	—	—	—	—	—
1940	 XIX	6	2	—	—	—	—	—	—	—	—	—
1939	 XX	I	—	—	—	—	—	—	—	I	—	—
Total number		136	246	465	197	198	199	154	198	199	201	106

Sample Nos.		12	13	14	15	16	17	18	19	20	21	22
		Aug.	Sept. Oct.	Oct.	Nov.	Oct.	Aug.	Oct.	March	March	June	July
1956	 III	—	—	—	5	—	11	—	—	2	—	2
1955	 IV	—	3	4	9	—	36	I	18	53	I	6
1954	 V	I	5	7	9	3	27	I	8	7	3	2
1953	 VI	9	11	8	29	16	30	3	2	I	54	39
1952	 VII	7	10	23	16	15	12	6	16	5	21	12
1951	 VIII	—	3	10	7	6	9	2	I	—	4	9
1950	 IX	14	9	26	12	50	11	6	5	I	14	15
1949	 X	5	I	6	5	14	I	4	3	3	6	—
1948	 XI	3	4	12	10	12	2	3	—	—	I	—
1947	 XII	37	20	61	39	84	5	14	3	—	2	8
1946	 XIII	4	3	3	7	3	—	I	I	—	—	—
1945	 XIV	6	5	11	11	10	I	3	I	I	—	I
1944	 XV	I	—	I	I	2	—	I	—	—	—	—
1943	 XVI	I	I	I	—	3	I	I	—	—	—	—
1942	 XVII	9	3	5	9	6	—	2	2	—	—	—
1941	 XVIII	—	—	2	—	I	—	I	—	—	—	—
1940	 XIX	2	—	4	3	2	—	4	2	—	—	—
1939	 XX	—	—	—	—	—	—	—	—	—	—	—
1938	 XXI	—	I	—	—	I	—	—	—	—	—	—
Total number		99	79	184	172	228	146	53	62	73	106	94

their order of frequency, are predominant: 1955, 1953, and 1954. The 1955 year-class is the richest in No. 19, next comes 1952. The 1952 year-class dominated in several of the samples from Godthåb fjord in 1958. Therefore it is surprising that it is important in only one of the samples from 1959.

Sample No. 20 is taken with shrimp trawl and includes therefore only small cod of the 1955 year-class.

In three samples (Nos. 21, 22, and 23) from subdivision 1E the 1953 year-class is the most

important one. In No. 21 from June it accounts for more than 50%. In No. 23 from October, the 1947 and 1950 year-classes are more abundantly represented than in the two other samples, yielding between 15% and 20%.

In eight samples (Nos. 24—31) from subdivision 1F, the 1947 year-class is very weak, while the 1950 year-class on the whole is more numerous than in the other subdivisions. It is predominant in two samples (Nos. 28 and 31) and second in three samples (Nos. 25, 26, and 30). The 1953 year-class

Table 7 (continued)

Year-class	Sample Nos.	23 Oct.	24 Sept.	25 Sept.	26 Aug. Sept. Oct.	27 July	28 July Aug. Sept.	29 Aug.	30 Aug.	31 Sept. Oct.
Age-group										
1956	III	1	53	1	26	—	—	—	2	7
1955	IV	8	9	6	14	20	2	2	2	4
1954	V	8	3	3	2	44	7	3	4	7
1953	VI	53	35	76	46	124	56	92	80	86
1952	VII	20	14	34	17	17	32	42	35	49
1951	VIII	14	3	22	12	5	20	17	19	36
1950	IX	36	19	59	28	24	68	32	46	127
1949	X	7	4	16	2	9	26	7	8	26
1948	XI	9	1	4	—	2	3	1	—	4
1947	XII	36	6	19	6	4	21	4	3	45
1946	XIII	—	2	4	—	—	1	—	—	3
1945	XIV	6	3	1	1	1	6	—	—	—
1944	XV	—	—	—	—	—	3	—	—	1
1943	XVI	1	—	1	—	—	1	—	—	—
1942	XVII	—	—	1	—	—	4	—	—	5
1940	XIX	—	—	—	1	—	—	—	—	—
Total number		199	152	247	155	250	250	200	199	400

is here, as in most of the other subdivisions, the strongest, predominating in five of the eight samples. In No. 24 the 1956-class is the richest with about

35%. This year-class was of some importance only in one sample from the other subdivisions, viz. No. 11 from the mouth of Godthåb fjord (1D).

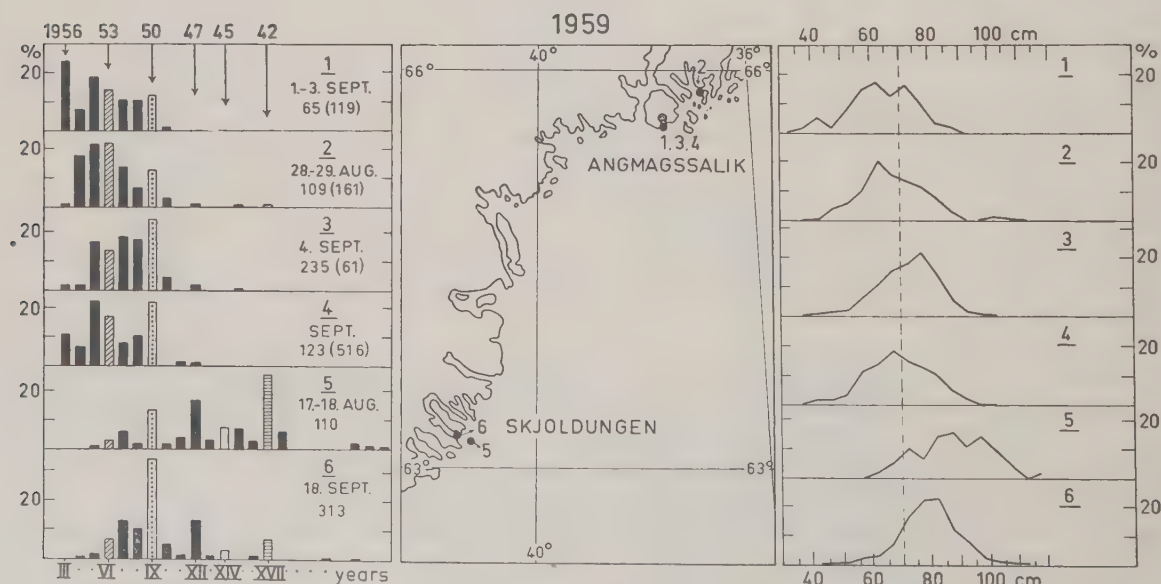


Figure 6. Age and length distribution of cod from East Greenland.

Table 8. Age composition from inshore waters and the fjords of East Greenland in 1959, together with the mean lengths of males and females at each age

Sample Nos.		1 Angmagssalik 65°49'N, 36°59'W 1.-3. Sept., 90-150 m Hand-line			2 Kungmiut 65°48'N, 37°01'W 28.-29. Aug., 130-180 m Hand-line			3 Angmagssalik 65°35'N, 37°35'W 4. Sept., 150 m Hand-line		
		cm			cm			cm		
Year-class	Age-group	No.	♂♂	♀♀	No.	♂♂	♀♀	No.	♂♂	♀♀
1956	III	16	41.0	39.4	1	—	44.0	3	—	39.3
1955	IV	5	47.7	52.5	19	50.7	47.2	4	47.0	53.0
1954	V	12	58.8	57.1	23	60.7	58.8	38	62.1	61.9
1953	VI	9	67.2	59.3	24	65.7	63.6	32	65.6	67.8
1952	VII	7	67.2	64.0	15	69.3	71.0	44	72.7	72.7
1951	VIII	7	75.5	72.2	7	70.8	65.0	42	77.5	74.9
1950	IX	8	73.3	83.5	14	73.9	77.8	58	81.3	80.3
1949	X	1	—	80.0	3	79.0	89.0	10	76.8	79.8
1947	XII	—	—	—	1	—	87.0	3	82.0	80.0
1944	XV	—	—	—	1	—	106.0	1	—	126.0
1942	XVII	—	—	—	1	—	102.0	—	—	—
Total number		65			109			235		

Sample Nos.		4 Angmagssalik 65°35'N, 37°35'W September Hand-line			5 Off Skjoldungen 63°10'N, 41°04'W 17.-18. Aug., 150-220 m Long-line			6 Anarnitsok 63°10'N, 41°13'W 18. September Hand-line		
		cm			cm			cm		
Year-class	Age-group	No.	♂♂	♀♀	No.	♂♂	♀♀	No.	♂♂	♀♀
1956	III	13	40.2	42.2	—	—	—	—	—	—
1955	IV	8	52.3	50.5	—	—	—	2	48.5	—
1954	V	28	60.1	60.7	1	—	61.0	5	53.0	63.0
1953	VI	21	69.0	69.1	3	66.5	72.0	20	63.8	64.6
1952	VII	11	70.5	73.9	6	65.3	75.0	39	70.3	71.0
1951	VIII	13	78.9	75.4	2	67.5	—	32	73.0	75.2
1950	IX	27	79.7	83.6	15	80.0	77.9	107	78.8	80.8
1949	X	—	—	—	2	89.0	89.0	17	80.1	82.5
1948	XI	1	—	89.0	4	81.3	80.0	6	80.0	82.8
1947	XII	1	84.0	—	18	80.5	84.7	42	82.7	85.2
1946	XIII	—	—	—	3	—	88.0	5	83.5	89.0
1945	XIV	—	—	—	8	86.7	95.2	12	83.8	92.6
1944	XV	—	—	—	7	97.3	93.8	—	—	—
1943	XVI	—	—	—	3	—	94.0	3	92.0	89.0
1942	XVII	—	—	—	28	89.9	102.7	21	93.5	91.2
1941	XVIII	—	—	—	6	93.0	104.0	—	—	—
1938	XXI	—	—	—	—	—	—	1	—	105.0
1936	XXIII	—	—	—	2	—	117.0	1	104.0	—
1935	XXIV	—	—	—	1	—	101.0	—	—	—
1934	XXV	—	—	—	1	—	100.0	—	—	—
Total number		123			110			313		

East Greenland

(Figure 6; Table 8)

The investigations off SE Greenland (60°—66°N) during the two preceding years were continued from 9. August to 18. September 1959. The researches were concentrated in the two populated areas Skjoldungen (63°15'N) and Angmagssalik fjord area (65°45'N). Contrary to 1957 and 1958, the work was much impeded by polar ice. It was impossible to get to the banks off Angmagssalik, and even in the fjords the large quantities of ice hindered

the operations. The cod fishery which started successfully in 1958 at Kungmiut in the Angmagssalik district where Greenlandic rowing-boats with hand-lines and a salting mother vessel caught 865 tons of cod, yielded only 539 tons in 1959. The mother vessel had to leave earlier than planned due to the adverse ice conditions. The cod caught in the fjord area in 1958 was of a very fine quality; in 1959, however, it was very lean.

Table 8 and Figure 6 present age and length distributions of six samples of cod from Skjoldungen and Angmagssalik. No. 5 is a long-line catch from

the bank off Skjoldungen, Fylkis Bank, the remainder are hand-line catches. Figure 6 shows that the catches from Skjoldungen mainly consist of large, old cod, whilst those from Angmagssalik almost exclusively contain smaller, younger cod. In the catches from Skjoldungen old cod, 10 years or more, account for 79% of the catches, while at Angmagssalik cod of that age only make up 3.6%.

The 1950 year-class which in the two preceding years, especially in 1958, was of great importance in the catches, is much reduced in strength in 1959. In the sample from Skjoldungen taken on 18. September this year-class, however, is predominating with 35%. The strong reduction of the 1950 year-class may indicate that an extensive emigration to Icelandic waters has occurred; this hypothesis is confirmed by returns from the tagging experiments of the two preceding years. The six year-classes younger than 1950, present in the Angmagssalik samples, occur in very much the same quantities; among these year-classes no single one is especially predominant.

A fairly rich occurrence of small cod of age-groups I—III was observed in the harbour of Skjoldungen in mid-August. As the bottom did not permit the use of fine-meshed seines, fishery with small jigs was attempted. Only 13 cod were caught, of which 8 belonged to age-groups I, and 5

to group II. At Tasiussaq near Angmagssalik and in the inner part of Angmagssalik fjord some few young cod were observed and according to size they belonged to the II-group. It was here, as off Skjoldungen, impossible to fish with seines, and jig yielded only few cod. The observations show, however, that small, young cod occur in the coastal area and in the fjords around Angmagssalik.

Tagging Experiments

(Tables 9–12)

In 1959 a total of 4,091 cod were tagged in West Greenland waters and 966 cod at East Greenland. 596 tagged cod were recovered.

The recaptures made in 1959 are shown in Tables 9 and 11 tabulated according to age, year of liberation, and place of recapture. As shown in Table 10 a total of 8 cod tagged at West Greenland were recaptured at East Greenland in 1959, as follows: 1 from the 1955 taggings, 5 from the 1957 liberations, and 2 from those of 1958. It was to be expected that most returns would come from the southern subdivisions 1E and 1F; however, only one of these recaptures was from taggings carried out in 1F although many cod are tagged in 1F every year. The returns are distributed as follows:—

1B	1C	1D	1E	1F
1	1	5	0	1

Table 9. Cod tagged at West Greenland and recaptured at West Greenland (Gr.) and at Iceland (Ic.) in 1959, tabulated according to age and year of liberation

Year-class	Age-group	1952 Gr. Ic.	1953 Gr. Ic.	1954 Gr. Ic.	1955 Gr. Ic.	1956 Gr. Ic.	1957 Gr. Ic.	1958 Gr. Ic.	1959 Gr. Ic.	Total Gr.	%	Ic.
1940	XIX	—	—	—	—	—	1 —	—	—	1	0.3	—
1942	XVII	—	1 —	—	—	—	—	—	—	1	0.3	—
1943	XVI	—	—	—	—	—	1 —	—	—	1	0.3	—
1945	XIV	—	—	1 —	—	3 —	—	3 —	1 —	8	2.2	—
1946	XIII	—	—	—	—	—	—	1 —	—	1	0.3	—
1947	XII	1 —	2 —	9 —	4 —	4 —	6 1 ¹	6 —	3 —	35	9.6	1 ¹)
1948	XI	—	—	2 —	—	2 —	1 —	2 —	—	7	1.9	—
1949	X	—	1 —	2 1	1 —	2 —	3 2	1 1	—	10	2.7	4
1950	IX	—	—	2 —	2 1	9 —	25 6 ²)	23 3 ¹)	4 —	65	17.8	10 1 ¹) ²)
1951	VIII	—	—	—	—	1 —	8 1 ¹)	8 —	3 —	20	5.5	1 ¹)
1952	VII	—	—	—	1 —	4 —	56 —	25 —	2 —	88	24.1	—
1953	VI	—	—	—	—	—	36 2 ²)	44 —	6 —	86	23.6	2 ²)
1954	V	—	—	—	—	2 —	7 —	8 1 ³)	2 —	19	5.2	1 ³)
1955	IV	—	—	—	—	—	4 —	—	6 —	10	2.7	—
1956	III	—	—	—	—	—	—	1 —	10 —	11	3.0	—
1957	II	—	—	—	—	—	—	—	2 —	2	0.5	—
??		1 —	1 —	4 1	6 2 ¹)	15 1	50 3 ²)	62 2 ²)	22 —	161		9 1 ¹) ⁴)
Total		2 —	5 —	20 2	14 3 ¹)	42 1	198 15 ⁵)	184 7 ⁶)	61 —	526		287 ⁷)

¹) including one recaptured on Fylkis Bank.

²) including one recaptured at East Greenland.

³) including one recaptured at Newfoundland.

⁴) including two recaptured at East Greenland.

⁵) including two recaptured on Fylkis Bank and three at East Greenland.

⁶) including one recaptured on Fylkis Bank, one at East Greenland and one at Newfoundland.

⁷) including four recaptured on Fylkis Bank, four at East Greenland and one at Newfoundland.

Table 10. Cod tagged at East Greenland and recaptured at East Greenland (East), Iceland (Icel.), and West Greenland (West) in 1959, tabulated according to age and year of liberation

Year-class	Age-group	1957			1958			1959		
		East	Icel.	West	East	Icel.	West	East	Icel.	West
1943	XVI	—	—	—	—	—	—	—	—	1
1949	X	—	3	—	1 ¹⁾	1	1	1	—	—
1950	IX	—	2 ¹⁾	4	—	2 ²⁾	8	—	—	—
1951	VIII	—	1	—	1 ¹⁾	2	—	—	—	—
1952	VII	—	—	—	1 ¹⁾	—	—	—	—	—
1953	VI	—	—	—	—	1	—	—	—	—
??		1	2	—	1	7	1	—	—	—
Total		3 ¹⁾	10	—	6 ¹⁾²⁾	19	2	1	—	1

1) five on Dohrn Bank.

2) two off East Greenland.

Of the five cod recovered in 1D, three fish were tagged on the Fylla Bank and two in the coastal area of Godthåb. The three recoveries from the other subdivisions were all tagged on the coast. In 1959, 966 cod were tagged at East Greenland, that is, 13 off the coast at 60°42'N, 79 at Skjoldungen, and 874 in the Angmagssalik district.

The tagging experiments carried out during 1927/1933 showed already that the East Greenland cod is connected with the Icelandic stock. Of 772 cod tagged at Angmagssalik in that period 20 were recovered, that is, 18 from Iceland but only 2 from East Greenland where the fishery in that period was rather insignificant.

In 1959, 29 returns of cod tagged at East Greenland were reported from Iceland, as shown in Tables 10 and 12. Age analyses on 20 of these fish showed that 12 belonged to the 1950 year-class. From the same tagging experiment 10 fish were recaptured at East Greenland in 1959, but only 3 at West Greenland. Of these latter, one is from the

Table 12. Cod tagged at East Greenland and recaptured in 1959

	East Greenland	Iceland	West Greenland
Greenland	3	—	1
Norway	—	—	1
Iceland	1	13	—
United Kingdom ...	—	4	—
Germany	6	12	—
Portugal	—	—	1
Total	10	29	3

coast in subdivision 1C, one from a fjord in 1F, and one was recovered at Cape Farewell (1F).

P. M. HANSEN

Faroese Investigations

(Figures 7-8)

Faroese investigations of commercial catches of cod from the West Greenland banks were carried out for the first time in 1959. The observations were made partly on board the S/T "Skálaberg" (955 br. tons) in the period 30. April to 15. May, and partly on material collected from the M/C "Hamranes" (152 br. tons) from hand-line fishery in the period 3.—12. August.

As both vessels salted their catch (on board "Skálaberg" larger halibut were also frozen) only cod were landed. The total catch taken by the "Skálaberg" from 30. April to 15. May was 335 tons round fresh fish. Thereof marketable cod (above 50 cm) made up 277 tons; the remainder of the catch was distributed as follows:—

Table 11. Cod tagged at West Greenland in different years and recaptured in 1959

	West Greenland	Iceland	East Greenland
Greenland	227	—	—
Faroe Islands	13	—	—
Norway	43	—	—
Iceland	3	10	4
United Kingdom ...	20	1	—
France	7	—	—
Germany	17	8	4
U.S.S.R.	3	—	—
Spain	7	—	—
Portugal	186	1 ¹⁾	—
Total	526	20 ¹⁾	8

1) One recaptured at Newfoundland.

	Tons (approx.)
Small cod (below 50 cm) ...	33
<i>Sebastes marinus</i>	19
<i>Hippoglossoides platessoides</i> .	3
<i>Anarhichas</i> sp.	2
Other species	1
Total	58 tons

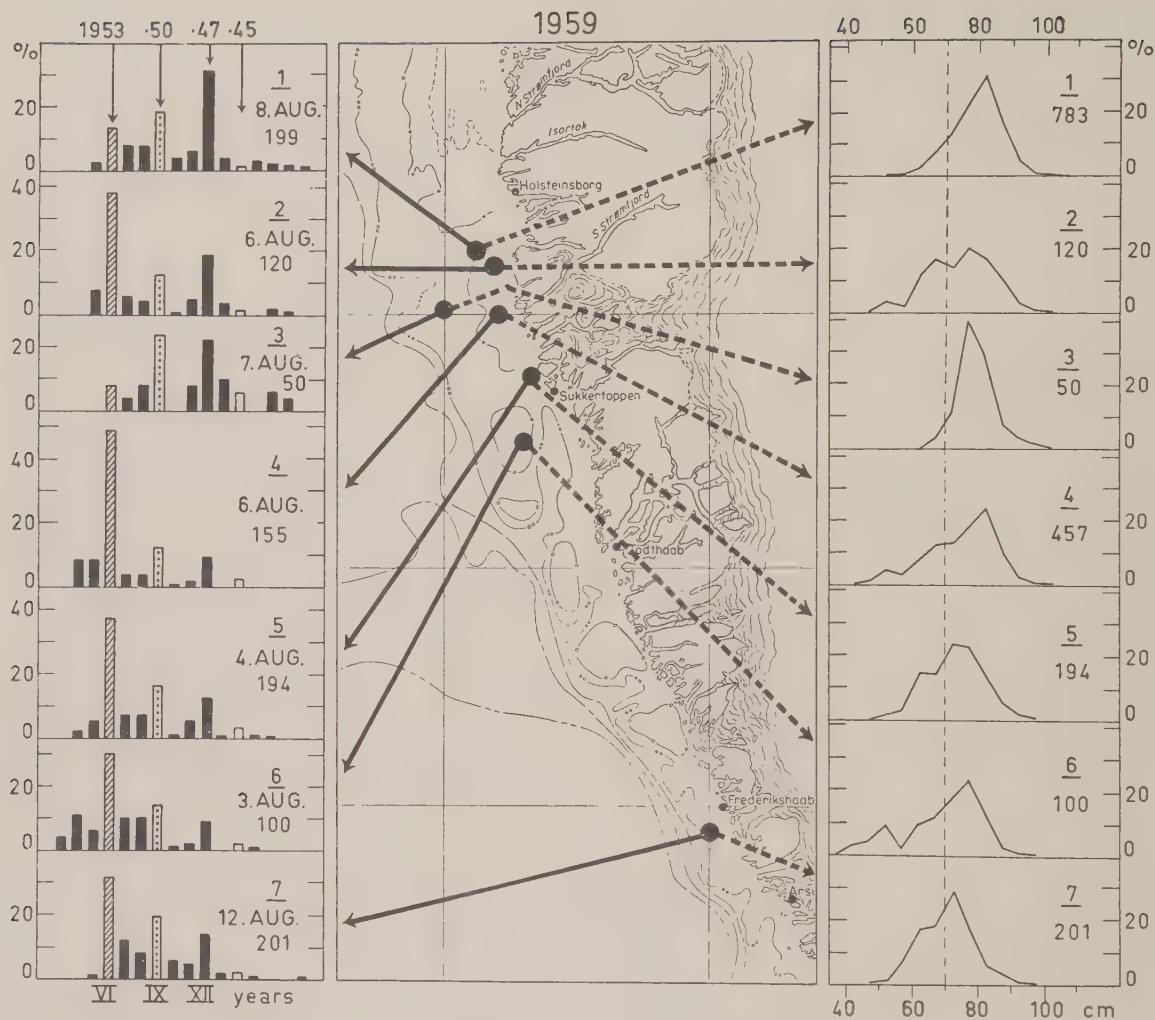


Figure 7. Age and length of cod, "Hamranes", August 1959.

Thus about 17% of the catch was discarded. Catfish and flatfish are as a rule alive when discarded, even after having been on the deck for a while. Also some small cod are able to swim down when discarded but the greater part flow at the surface, together with the redfish.

On the "Hamranes" the catch consisted almost exclusively of cod of a size suitable for salting as the lines do not catch so many small cod as the trawl; of other species only a few redfish and halibut were caught.

On board the two vessels a total of 2,645 otoliths were collected and 5,935 length measurements were made, as follows: "Skálaberg", 1,626 otoliths, 4,483 measurements; "Hamranes", 1,019 otoliths, 1,552 measurements. The data from "Skálaberg" were mainly from cod for salting, of the discarded small cod only a few samples were taken; they were

composed almost exclusively of 3—4 year-old cod (75% 3 year-olds, 25% 4 year-olds). The distribution of the discarded small cod was as follows:—

Length, cm	Number of fish	Length, cm	Number of fish
20—24	7	45—49	69
25—29	69	50—54	21
30—34	326	55—59	5
35—39	369	60—64	1
40—44	148		

Figures 7 and 8 present age and length distribution of the cod from "Skálaberg" and "Hamranes". The 1953 year-class is predominant in all the trawler catches but the 1950 year-class is also of some importance. In the line catches the 1953 year-class is also predominant in most localities, but the 1950 and 1947 year-classes are present in important quantities.

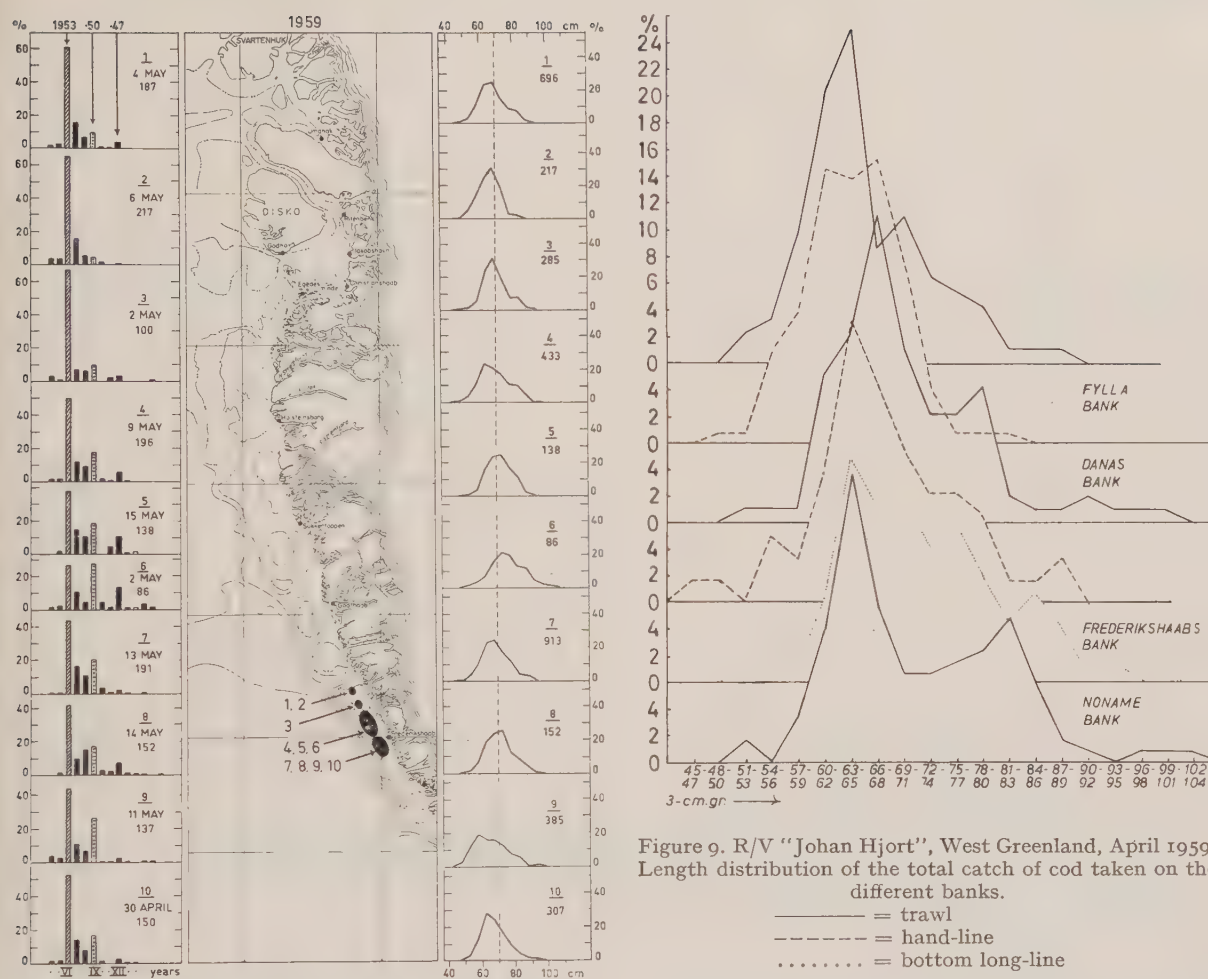


Figure 8. Age and length of cod, "Skálaberg", April/May 1959.

The spawning of the cod was in the main completed, only 2% of the mature females and a few more mature males had not yet finished spawning.

J. S. JOENSEN

Norwegian Investigations

(Figures 9-14; Tables 13-14)

West Greenland

In April 1959, no fish were registered with the echo-sounder over the banks, except on Frederikshåb and Fylla Banks where the bottom temperature was between 1° and 2°C. Samples of cod were taken there with hand-line. The cod were immature and relatively small. The mean length of cod on these two banks was 67.79 cm and 64.12 cm respectively.

Figure 9. R/V "Johan Hjort", West Greenland, April 1959. Length distribution of the total catch of cod taken on the different banks.

— = trawl
- - - = hand-line
..... = bottom long-line

On the other hand, shoals of fish, sometimes in heavy concentrations, were registered at the bottom on the western slopes of the banks. The depth varied from 200 m to 450 m. The temperature was always 4°C or above. The catches taken there by means of bottom long-line and trawl consisted of cod and redfish. Redfish dominated in the trawl catches.

Nearly all the cod were sexually mature. A small portion was already spent, but most of the fish were ready for spawning and a few had running milt or roe.

The samples show that cod may spawn on all the banks from Noname Bank in the south to Banana Bank in the north. Spawning starts probably first on the northern banks. Almost all mature cod from the Banana Bank had completed the spawning process, and the percentage of spent cod decreased from north to south. The spawning temperature seems to be on a lower level, at 4°C.

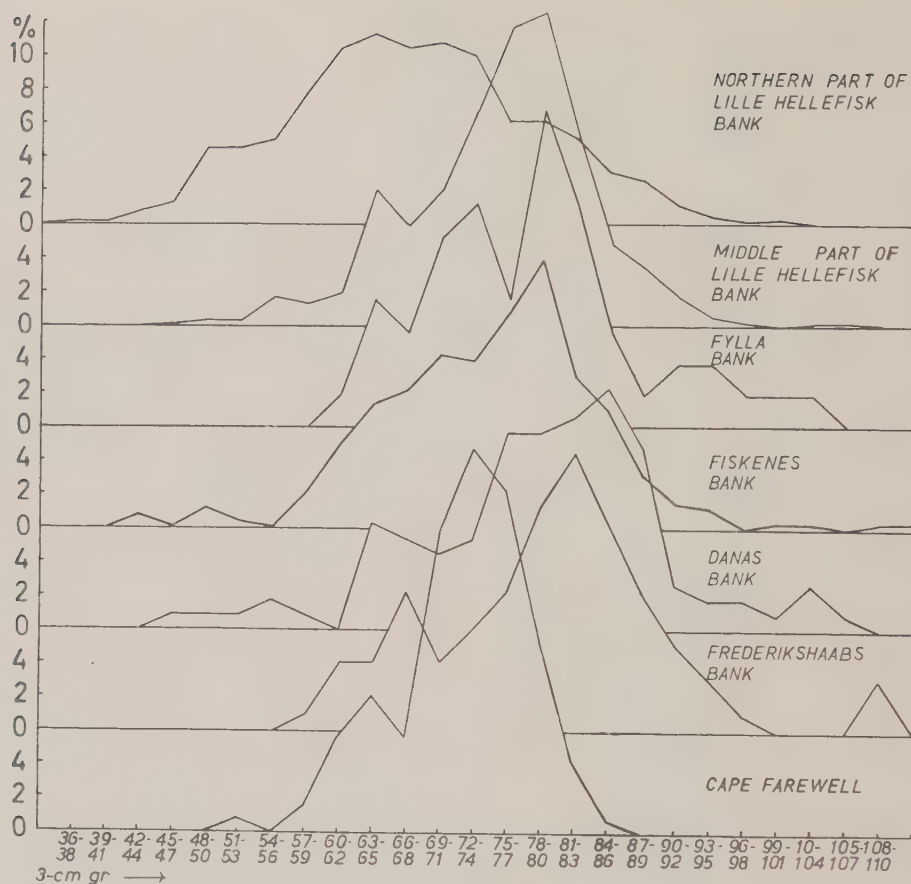


Figure 10. R/V "G. O. Sars", West Greenland, July/August 1959. Length distribution of the total catch of cod taken on the different banks.

Figure 9 shows the length distribution of cod caught with various types of gear on the different banks. The diagram gives hardly a true, but at least a rough picture of the length distribution of the cod population at this time of the year. In spite of the different selectivity of the gears used there is some evidence for concluding that: (1) relatively small fish dominate the population, (2) the mean length of the cod decreases from south to north. The mean length of the total catch of cod taken with hand-line and bottom long-line is relatively small, viz. 69.69 cm.

Registrations with the echo-sounder and the results of the fishing experiments on the cruise in July/August showed that the distribution of cod in 1959 was almost the same as in previous years. Very few cod were found on the southern banks, even in localities with favourable temperatures. The first dense concentration of cod was encountered in the central part of Lille Hellefiske Bank. Really large concentrations were encountered in the

northern part of Lille Hellefiske Bank where the cod was feeding heavily on sand-eels and capeline. Here the cod were standing near the bottom. No pelagic shoals were observed in the Holsteinsborg Deep in spite of great concentrations of sand-eels and capelin in the intermediate water layers where also the temperature conditions were favourable.

Figure 10 shows the length distribution of cod in the total long-line and hand-line catches taken on the different banks. In the mean lengths a slight decrease from south to north is noticeable, except in the samples from the Cape Farewell region and Fiskenes Bank. On Lille Hellefiske Bank where large concentrations of cod were encountered, a very marked variation in the mean lengths is observed. The samples from the middle part of the bank have a mean length of 74.91 cm, while the mean lengths of those of the northern part of the bank is 67.30 cm. The overall mean length of the samples of cod off West Greenland is 72.22 cm.

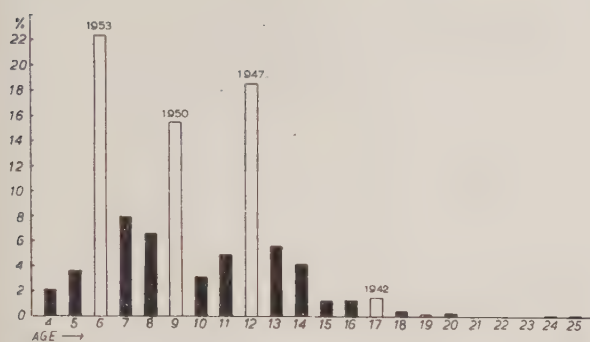


Figure 11. R/V "G. O. Sars", West Greenland, July/August 1959. Age composition of the total catch of cod taken by hand-line and bottom long-line.

The age composition of all cod taken by hand-line and bottom long-line in July/August is shown in Figure 11.

At present the 1953 year-class, with an overall mean length of 66.17 cm, is promising in the hook and line catches. The catches are, however, still much influenced by the 1950 and 1947 year-classes.

If compared with the catches taken in 1958 it is found that both the 1947 and 1950 year-classes have diminished in strength. The number of fish belonging to the 1953 year-class will probably increase in the hook and line catches next year. On the other hand, the mean length of the fish is expected to decrease still more due to the increase of the 1953 year-class and the decrease of the 1947 and 1950 year-classes.

East Greenland

In Tables 13 and 14 are listed the bottom long-line and hand-line stations in East Greenland waters. It is seen that only at some few stations no cod were present. At two stations fairly large concentrations of saithe were encountered, and at one station the haddock were plentiful. On 26.—28. August on Cape Dan Bank the concentrations of cod were much larger than indicated by Table 13, but for some reason the cod would not take the bait. Trawling in the same locality yielded reasonably good catches.

Figure 12 shows the length distribution of all the cod taken on bottom long-lines off the coast of East Greenland. The mean is 86.07 cm, in other words the proper commercial size for Norwegian long-line fishery.

Figure 13 shows the age composition of cod taken by hand-line and bottom long-line, and Figure 14 the age composition of those taken by trawl. The 1947 and 1950 year-classes dominate the line catches; in general, all the cod are of relatively



Figure 12. R/V "G. O. Sars", East Greenland, July/August 1959. Length distribution of the total catch of cod taken by bottom long-line.

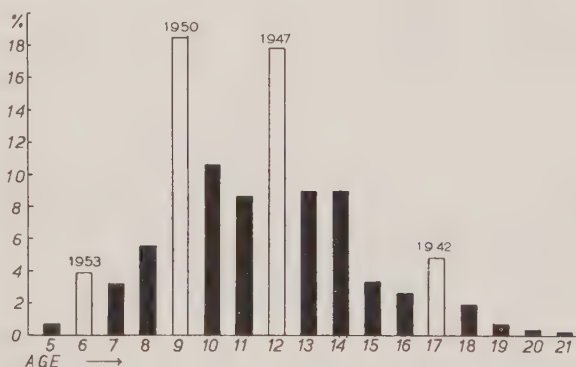


Figure 13. R/V "G. O. Sars", East Greenland, July/August 1959. Age composition of the total catch of cod taken on hand-line and bottom long-line.

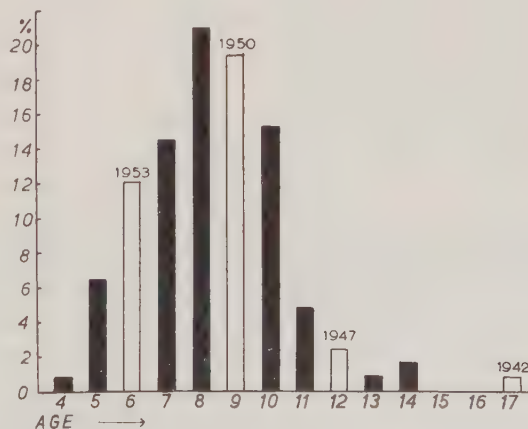


Figure 14. R/V "G. O. Sars", East Greenland, August 1959. Age composition of the cod taken by trawl on the Cape Dan Bank.

Table 13. "G. O. Sars", East Greenland, July/August 1959. Bottom long-line stations

Date	Position		Depth (m)	Number of hooks	Bottom temp. °C	Cod	Catch in number of fish			
	N	W					Haddock	Halibut	Redfish	Tusk
1. July	63°10'	40°04'	320	2000	4.86	16	0	2	9	78
2. July	63°29'	39°18'	250	2000	5.1	34	0	4	12	171
3. July	63°33'	37°50'	200	2000	4.5	58	0	25	5	66
4. July	63°59'	38°23'	250	1800	4.5	15	0	2	3	60
6. July	64°58'	36°58'	230	2000	4.9	49	0	0	2	64
7. July	65°35'	33°30'	270	2000	3.0	156	0	0	0	20
8. July	65°40'	31°54'	250	2000	5.0	207	0	2	1	6
9. July	66°02'	32°31'	285	2000	2.89	55	0	1	0	14
10. July	66°02'	29°27'	315	2000	0.89	Part of gear lost				—
11. July	65°50'	29°39'	350	2000	2.77	Gear lost				—
23. July	64°18'	39°55'	200	2000	3.6	64	0	11	0	3
23. July	63°58'	39°32'	240	1200	4.5	36	0	3	0	54
15. Aug.	59°49'	43°11'	170	2040	2.9	87	0	7	0	0
17. Aug.	60°37'	62°07'	190—200	2040	4.6	15	0	9	18	9
18. Aug.	61°07'	42°20'	180	2040	3.0	86	part	5	of gear lost	—
19. Aug.	61°35'	41°15'	200	1600	4.5	21	0	17	33	22
20. Aug.	62°04'	40°43'	165	1800	3.2	92	54	63	25	0
23. Aug.	63°13'	40°48'	240	1800	4.2	82	0	2	0	0
26. Aug.	65°13'	36°32'	200	1800	3.0	163	0	4	0	1
27. Aug.	65°13'	36°39'	210	1800	3.1	39	0	1	0	0
28. Aug.	65°16'	36°47'	190	1800	3.1	57	0	3	0	0

Table 14. "G. O. Sars", East Greenland, July/August 1959. Hand-line stations

Date	Position		Depth (m)	Number of hand- lines	Time fished (min)	Bottom temp. °C	Cod	Catch in number of fish			
	N	W						Haddock	Redfish	Saithe	Other fishes
1. July	63°10'	40°04'	320	4	120	4.86	0	1	20	0	1
2. July	63°25'	39°45'	240	4	45	5.8	5	0	0	0	0
2. July	63°29'	39°18'	250	4	150	5.1	2	2	9	0	4
3. July	63°39'	38°21'	210	3	20	4.5	1	0	1	0	0
3. July	63°44'	38°27'	250	4	15	4.5	0	0	1	0	0
3. July	63°30'	37°51'	200	2	20	4.5	0	0	0	0	0
3. July	63°33'	37°50'	210	4	150	4.5	5	0	0	23	0
6. July	65°14'	36°08'	230	4	30	4.07	15	0	1	0	0
6. July	65°19'	37°15'	180	4	70	4.5	5	0	0	0	0
6. July	64°58'	36°58'	230	4	200	4.9	3	0	20	0	0
7. July	65°22'	33°56'	250	3	40	2.9	0	0	1	0	0
8. July	65°40'	32°02'	240	4	60	5.0	2	0	0	33	0
22. July	65°26'	37°49'	170	4	180	3.3	45	0	0	0	0
22. July	65°04'	38°34'	170	4	40	3.9	38	0	0	0	0
23. July	64°50'	39°54'	200	—	25	—	Good catch				—
25. July	59°41'	43°22'	200	3	15	—	3	0	0	0	0
18. Aug.	61°07'	42°20'	180	4	120	3.0	68	0	0	0	0
19. Aug.	61°19'	41°34'	—	—	30	—	0	0	0	0	0
19. Aug.	61°35'	41°15'	200	3	120	4.5	1	0	70	0	0
26. Aug.	65°13'	36°32'	200	2	60	3.0	15	0	0	0	0

high age, between 9 and 14 years old. In contrast to West Greenland, the 1953 year-class does not appear to have any strength in the line catches taken off south-east Greenland.

The age composition of the cod taken by trawl on the Cape Dan Bank is different. There all the year-classes between 1949 and 1953 are relatively strong, and the 6—10 year-old fish constitute most of the catch.

ERLING BRATBERG

On the Spawning Stocks of Cod in East Greenland and Iceland Waters in 1959

(Figures 15-21; Tables 15-17)

1. Introduction

In April 1959, the Icelandic trawler "Fylkir" carried out fisheries investigations in East Greenland waters.

The main purpose of the expedition was to investigate the spawning stock of cod, as former Icelandic research in this area in June and July

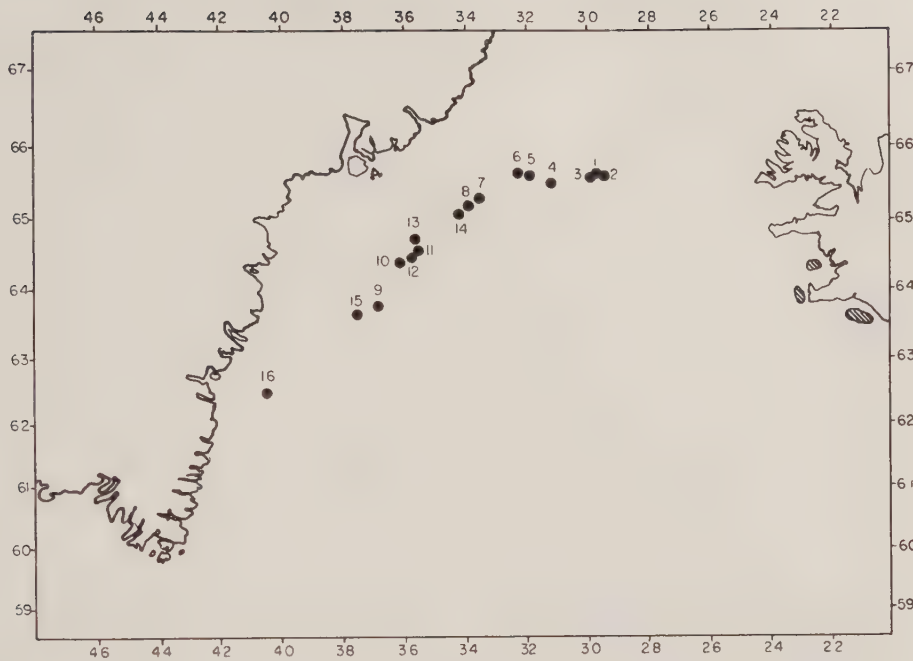


Figure 15. Position of stations. The hatched areas show where samples were collected at Iceland.

and observations from commercial trawlers indicated quite a considerable spawning of cod in these waters.

The position of the trawling stations is shown in Figure 15. The area investigated covers about 350 nautical miles along the slope of the East Greenland continental shelf. Due to unfavourable ice conditions, the southernmost part of the area could not be sampled at the same extent as the northern part.

As regards cod, otoliths of 1,646 fish were taken, together with measurements of length, sex, and sexual maturity. Another 387 fish were examined with regard to maturity, and length measurements were made on 1,770 fish. Stomach contents from cod were collected at the various fishing localities.

A total of 1,050 cod were tagged in six localities, mainly with the Lea hydrostatic tag.

The material from Iceland discussed in this paper is from cod caught on long-lines and in gill nets on the spawning grounds off the south-west coast, during the period January to May.

2. Spawning of cod at East Greenland

Table 15 shows the state of maturity of the cod on the various stations at East Greenland.

Of the whole material investigated, 9.7% was immature, which is in fairly good accordance with the situation found on the Icelandic spawning grounds.

Table 15. State of maturity of the cod at East Greenland in April 1959, expressed as percentages of the total (For stations, see Fig. 15)

State of maturity	Stations							
	1-3	4	5-6	7	14	10	15	16
Immature	10.4	9.2	22.1	11.3	6.0	10.7	0.7	4.3
Maturing	80.4	81.6	56.5	69.1	56.1	55.3	51.3	17.1
Spawning	2.4	3.6	3.4	4.1	15.6	17.3	43.3	70.1
Spawned	6.8	5.6	17.9	15.5	22.4	16.7	4.7	8.5
Total number invest.	337	250	262	291	487	150	150	234

Little spawning had started in the northern part of the area but most of the fish there had maturing gonads. The percentages of spawning fish increased southwards, with the highest figures found on the southernmost station, the Fylkir Bank. The catches in this area indicated a high concentration of spawning cod in about 200 m depth, with bottom temperatures of 4.2°–5.2°C.

The difference in time of spawning is partly explained by the fact that on the Fylkir Bank, where abt. 83% of the mature fish were actually spawning, the first-time spawners only constituted 37.3% of the sample. The stock there was also composed of older fish, 32.6% were 12 years and older compared with 3.8% at station Nos. 1–3 (Dohrn Bank).

On the Dohrn Bank, the first-time spawners constituted abt. 83% of the samples and it is a well known fact, that the first-time spawners start spawning later in the season than the older ones.

Table 16. Icelandic spawning stock of cod in 1959

Age-groups	Age at first spawning											Total
	3	4	5	6	7	8	9	10	11	12	13	
3	4	—	—	—	—	—	—	—	—	—	—	4
4	—	336	—	—	—	—	—	—	—	—	—	336
5	—	8	430	—	—	—	—	—	—	—	—	438
6	—	—	28	525	—	—	—	—	—	—	—	553
7	—	—	12	154	908	—	—	—	—	—	—	1,074
8	—	—	—	39	209	1 556	—	—	—	—	—	1,804
9	—	—	—	20	158	553	2,326	—	—	—	—	3,057
10	—	—	—	12	103	245	525	1,122	—	—	—	2,007
11	—	—	—	—	12	39	55	55	43	—	—	204
12	—	—	—	—	4	24	51	55	67	16	—	217
13	—	—	—	4	—	—	4	—	—	12	—	20
14	—	—	—	4	—	24	47	71	67	20	16	249
15	—	—	—	—	—	—	—	—	—	—	—	—
16	—	—	—	—	—	—	4	12	—	—	4	20
17	—	—	—	—	—	—	4	4	—	4	—	12
Total	4	344	470	758	1,394	2,441	3,016	1,319	177	52	20	9,995

Spawning classes											Total
Number	1	2	3	4	5	6	7	8	9		
	7,266	1,627	584	284	123	55	36	12	8		9,995

At the time of investigation, the beginning of April, the concentration of fish was highest on the Fylkir Bank. According to Dr. ARNO MEYER (Ann. Biol., 14: 121), German trawlers in 1957 shifted their fishery for cod from Angmagssalik to the Dohrn Bank in April and carried out successful cod fishery there in April and May. This may be caused by the later spawning of cod on the Dohrn Bank.

3. Onset of maturity

If we try to calculate the percentage of mature fish in each age-group present on the spawning grounds by observation of the gonads, we get a biased picture of the onset of maturity for the stock as a whole, as the mature part of the stock is in excess. The immature fish present on the spawning grounds belong mostly to the local population.

Figure 16, showing the onset of maturity of the East Greenland and Icelandic cod, is drawn from observation of the spawning zones in the otoliths. The curves represent the cumulative percentages of the spawning groups. A spawning group consists of several year-classes, which all have become mature at the same age. Both curves are based upon material from the 1959 spawning season.

The Icelandic cod becomes mature at a somewhat younger age than the East Greenland one. The Icelandic cod matures as early as 3 year-old and spawns for the first time as 4 year-old (see Table 16). As regards the East Greenland cod, some very few spawn for the first time as 5 year-old (see Table 17). As 9 year-old, 84.2% of the Icelandic cod and 80.4% of the East Greenland ones have started

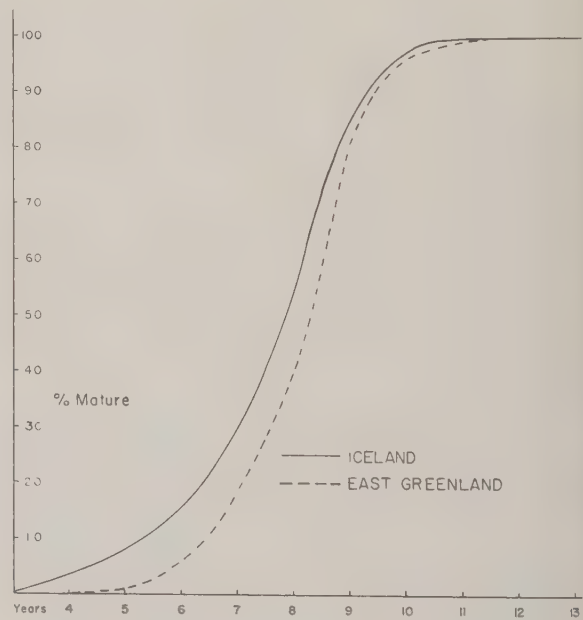


Figure 16. Onset of maturity of East Greenland and Icelandic stocks of cod.

spawning and as 10 year-old over 95% of both stocks have entered into the spawning population.

In both stocks we have still older first-time spawners. At East Greenland, 0.4% of the cod were spawning for the first time as 13 year-old and on the Icelandic spawning grounds 0.2% were also spawning for the first time at that age.

Table 17. East Greenland spawning stock of cod in 1959

Age-groups	Age at first spawning										Total
	5	6	7	8	9	10	11	12	13	14	
5	59	—	—	—	—	—	—	—	—	—	59
6	—	410	—	—	—	—	—	—	—	—	410
7	—	59	769	—	—	—	—	—	—	—	828
8	—	7	132	1,193	—	—	—	—	—	—	1,332
9	—	44	176	388	3,572	—	—	—	—	—	4,180
10	—	—	37	102	300	1,362	—	—	—	—	1,801
11	—	—	29	73	15	44	102	—	—	—	263
12	—	—	66	168	81	81	95	44	—	—	535
13	—	—	15	37	37	29	22	15	7	—	162
14	—	—	59	73	59	7	66	29	22	7	322
15	—	—	—	—	15	—	—	—	—	—	15
16	—	7	15	15	7	—	7	—	7	—	58
17	—	—	15	7	—	—	—	15	—	—	37
Total	59	527	1,313	2,056	4,086	1,523	292	103	36	7	10,002

	Spawning classes											Total
	1	2	3	4	5	6	7	8	9	10	11	
Number	7,225	1,055	432	337	241	184	103	66	15	22	22	10,002

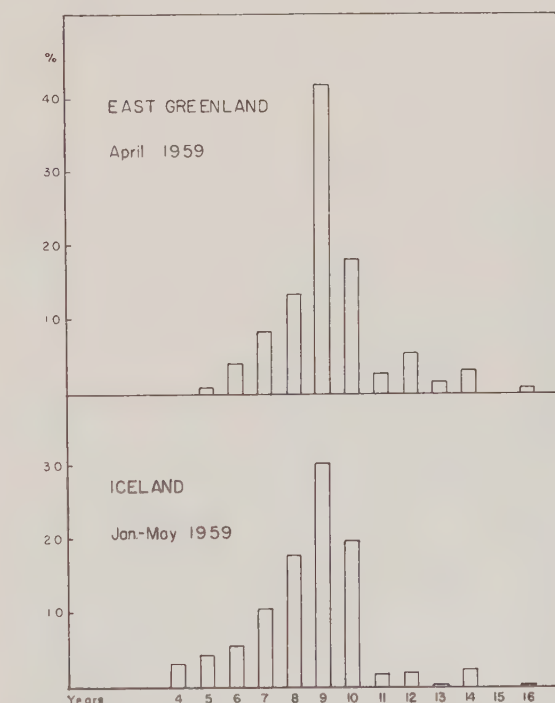
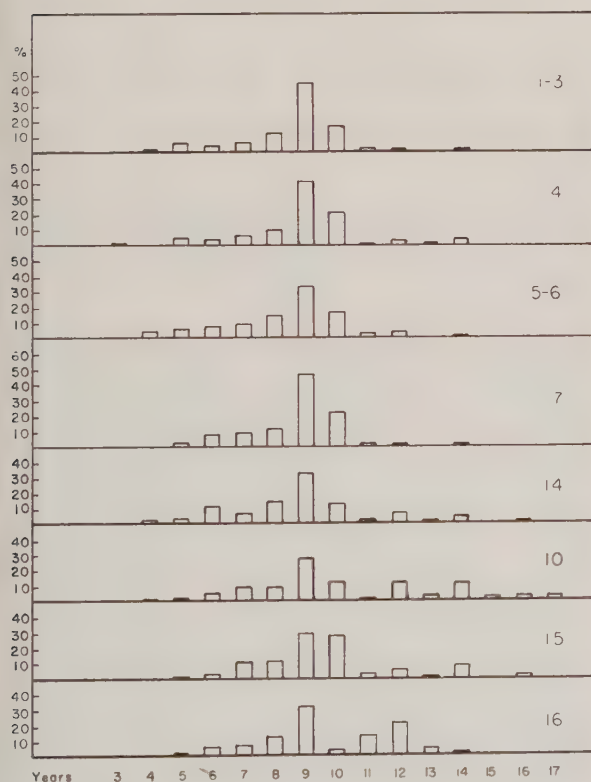


Figure 17. Age distribution of cod at East Greenland in April 1959. For position of stations, see Fig. 15.

Figure 18. Age distribution of the East Greenland and Icelandic stocks of spawning cod in 1959.

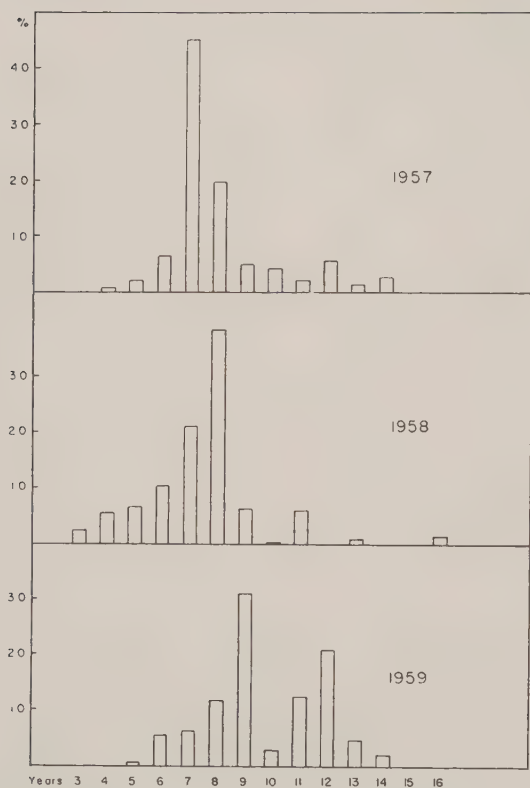


Figure 19. Age distribution of cod on Fylkir Bank (St. No. 16 in Fig. 15) in the years 1957/1959.

4. Age distribution

Figure 17 shows that the age distribution of the cod from the various localities at East Greenland is fairly homogenous. The 1949, 1950, and 1951 year-classes are predominant in all the samples. At the three southernmost stations, the 1947 and 1945 year-classes are still important. On the Fylkir Bank the 1947 year-class, for instance, constituted as much as 21% of the catch.

Figure 18 shows all the samples from East Greenland in 1959 taken together and also the age distribution of the spawning stock of cod on the Icelandic spawning grounds in 1959.

The main difference between the two stocks is the following: On the Icelandic spawning grounds the 1954 year-class was of great importance to the cod fishery in January and February, but only 20% had attained sexual maturity. This year-class made 3.4% of the mature part of the stock, but if we include the immature part also, it constituted as much as 13% of the total catch. This figure is very high, compared with the 0.6% found for this age-group as a mean on the spawning grounds. This year-class was also found at East Greenland, but

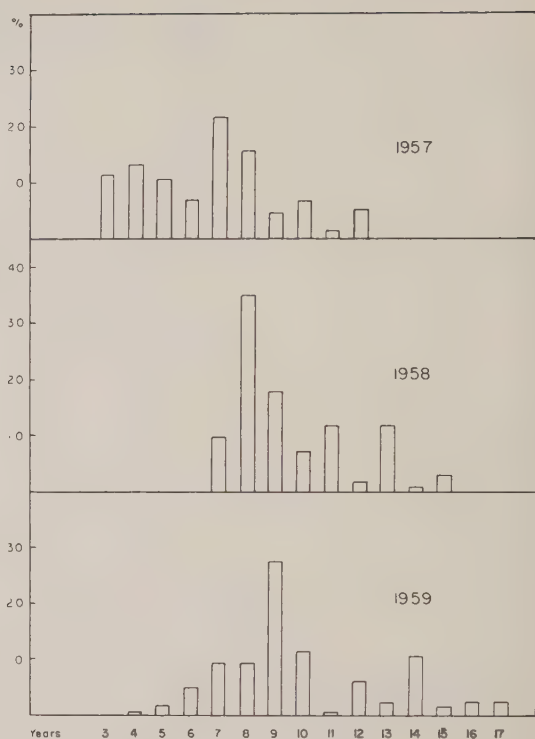


Figure 20. Age distribution of cod at Jónsmid (Angmagssalik) in the years 1957/1959. Station No. 10 in Fig. 15.

in much less quantities as it had not yet become mature.

The 1950 year-class is predominant in both areas. At East Greenland it constituted 41.8% of the spawning stock against 30.6% at Iceland. The 1947 and 1945 year-classes were also a little stronger at Greenland than at Iceland.

In spite of these numerical differences, the age distribution as a whole is strikingly similar for both areas. This similarity might be caused by a mixing of these two stocks or the main factors affecting the strength of the year-classes may be the same for both areas. We know very little about the immature part of the East Greenland stock of cod, but a further knowledge of this part of the population is important to understand the connexion between the two stocks.

Figures 19 and 20 show the age distribution of cod at East Greenland in 1957, 1958, and 1959 on two fishing banks where Icelandic trawlers have been fishing in recent years. The samples from the Fylkir Bank in 1957 and 1958 are from June, and the sample from Jónsmid (Angmagssalik) in 1957 is also from June. The other samples are from April. There is a consistent dominance of the 1950 year-class in both localities and the dominance of

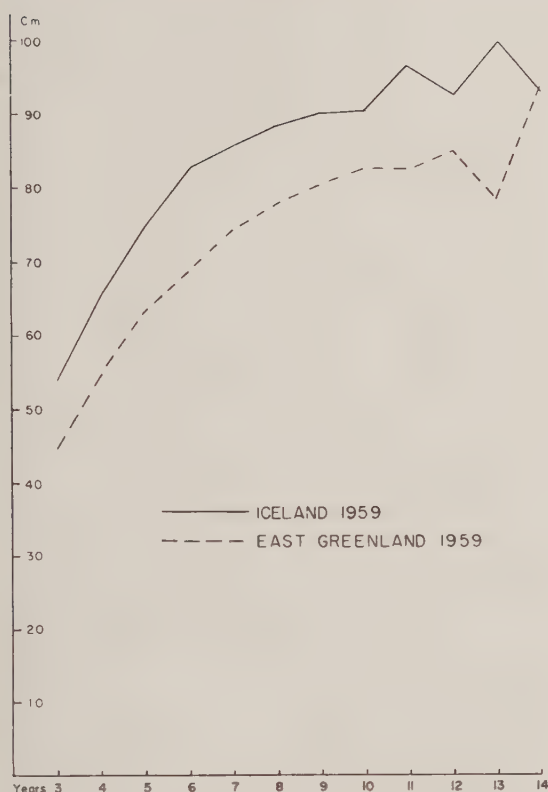


Figure 21. Average lengths of the various year-classes at East Greenland and Iceland in 1959.

the 1949, 1947, and 1945 year-classes on Jónsmid is also well marked in all years, in spite of the different time of sampling.

5. Growth

The average lengths of the various year-classes at East Greenland and Iceland are plotted in Figure 21. There is a difference of 8–14 cm in the average lengths of age-groups V to X. This difference becomes less with increasing age. The 1945 year-class, for instance, has even a somewhat higher average length at East Greenland than at Iceland.

As regards the two abundant year-classes from 1949 and 1950, there is a clear increase in the average lengths of these from the northernmost station to station No. 10. The average lengths then suddenly drop on the two southernmost stations.

The author has expressed before, that certain irregularities in the rate of growth of the East Greenland cod might be caused by an admixture of the faster growing Icelandic cod (Ann. Biol., 15). The difference in the average lengths of the year-classes in the northern and southern part of the area investigated, seems to confirm this view. The

cod on the south-east coast of Greenland would then be more related to the cod on the south-west coast of Greenland. Marking experiments in this area may answer this.

JÓN JÓNSSON

German Investigations

(Figures 22–24)

West Greenland

The stock of spawning cod present on the western slope of Fylla Bank was composed of considerably younger specimens than in 1958, a fact due to the new, rich 1953 year-class appearing for the first time in large quantities in the spawning shoals. This year-class contributed in March and April 1959, 72% of the German trawl catches.

The average length of the 1953 cod was 62 cm; therefore the average length of the total catch decreased from 76 cm in February/May 1958 to 63 cm in 1959 (Fig. 22 A). 74% of the fish caught were mature, 26% still immature. Of the 1953 year-class, 75% were mature. By mid-March all cod were still ready for spawning; by mid-April the majority of the older year-classes were either spent or spawning; the 1953 cod, however, were mostly preparing for spawning.

Considerably larger cod of an average length of 72 cm, were caught in June in the region of Dana Bank where they were standing at considerable depth, obviously due to the hydrographic situation (exceptionally much ice). But also there (Fig. 22B) the 1953 year-class was the strongest with 31%, followed by 1950, 23%, and 1947, 15%. The mean length for 6 year-old cod was 65 cm, for 9 year-olds, 77 cm, and for 12 year-olds, 79 cm.

During a search trip by the end of December 1959, only few cod were encountered on the usual fishing grounds on the western slopes of Noname and Fylla Banks. Noteworthy is a good catch taken on the inner slope of Fylla Bank which further confirms Birger RASMUSSEN's hypothesis that the cod migrations take place in autumn and winter. The 1953 year-class constituted 50% of this catch and the cod had by the end of their seventh feeding period attained a length of 72 cm. A somewhat larger catch taken off Sermersut, S of Noname Bank, showed again (A. MEYER, ICNAF Rep. 1958) that the 1956 year-class occurs numerous off the southern part of West Greenland as well as off South Greenland.

In the region of Sermersut/Dana Bank 221 cod were tagged with a yellow, elongated plastic tag carrying the letters DHB and an additional yellow plastic flap.

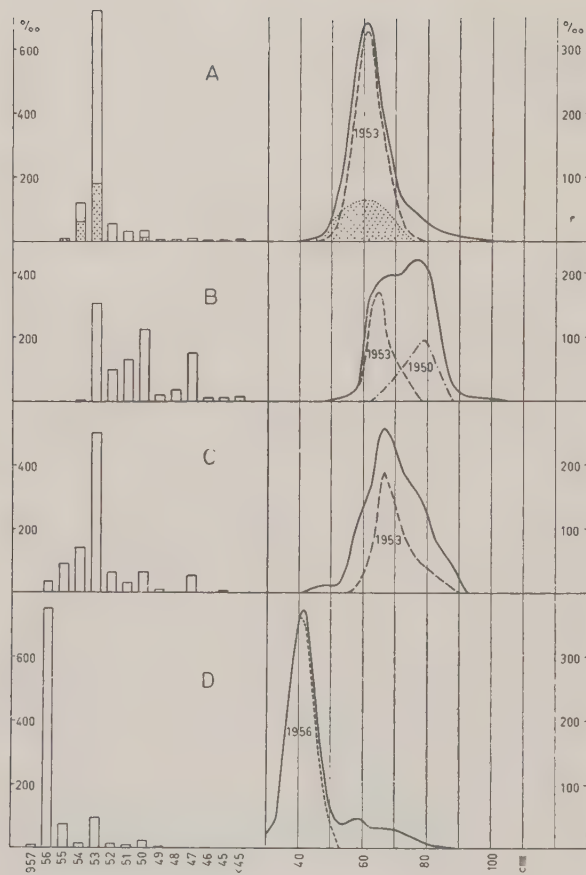


Figure 22. Age and length distribution (‰) of cod from West Greenland.

- Cod from Fylla Bank landed by trawlers in March and April 1959. Dotted part represents immature fish.
- Cod from Dana Bank landed by trawlers in June and July 1959.
- Cod from the eastern slope of Fylla Bank fished by a scouting trawler on 18. December 1959.
- Cod taken off Sermersut by scouting trawler on 18. December 1959.

South Greenland

Also off South Greenland (south of 60°45'N) the stock of cod has become younger since 1958. In the catches taken by German trawlers off Nanortalik Bank in late autumn, the 1953 year-class predominated with 52% (Fig. 23A).

On the search trips in autumn and winter, larger and older cod were observed farther eastward, off Cape Farewell (Fig. 23B), and the 1956 year-class also occurred more plentifully in the catches from Julianehåb Bay, west of Nanortalik (Fig. 23C). Already in 1957, R/V "Anton Dohrn" caught in that bay large quantities of the 1953 year-class, then 4 years old. Now, in its turn, the 1956 year-

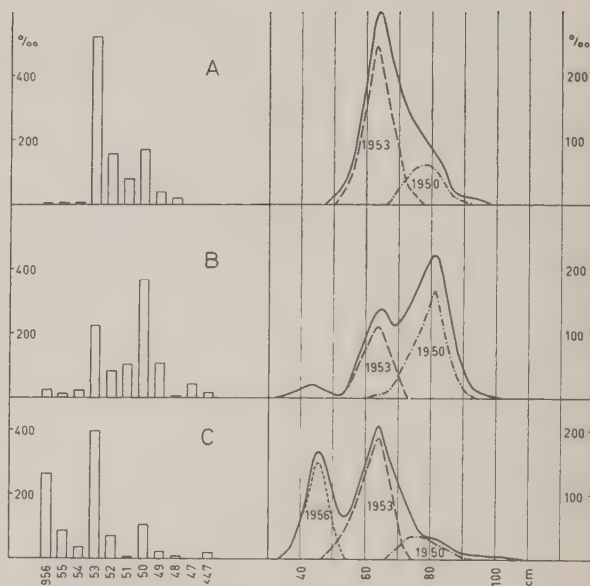


Figure 23. Age and length distribution (‰) of cod from South Greenland.

- Cod from Nanortalik Bank landed by trawlers during September/December 1959.
- Cod taken off Cape Farewell by scouting trawler on 25. October 1959.
- Cod fished off Julianehåb by scouting trawler on 17. December 1959.

class was numerous (26%) in the catches taken in Julianehåb Bay and also off Sermersut (Fig. 22D) and it is to be expected that this 1956 year-class, which does not appear to be important off West Greenland, will become of importance for the fishery in South Greenland as from 1962. By the end of 1959 the average lengths of the three important year-classes were: 1956, 54 cm; 1953, 63 cm; and 1950, 78 cm.

The two research trips offered an opportunity to tag cod off South Greenland. The tagging experiments included 215 cod which were tagged partly with yellow DHB tags with yellow plastic flaps and partly with numbered, blue plastic tags with red flaps. These tagging experiments are intended to increase our knowledge of the East Greenland cod stock whose feeding areas obviously are to be found off South Greenland. Owing to an exceptionally early occurrence of ice, the taggings in December could only be carried out to a restricted extent.

East Greenland

Since the R/V "Anton Dohrn" in September 1955 found a large stock of redfish on the Anton Dohrn Bank the German fishery off East Greenland has yielded the following quantities of fish (in tons):—

	1955		1956		1957		1958		1959	
Total	46,067	%	44,683	%	21,804	%	14,538	%	30,844	%
Cod	3,001	6.5	7,437	16.6	5,838	26.8	4,553	31.3	9,691	31.4
Redfish	40,948	88.9	33,094	74.1	13,638	62.5	8,883	61.1	19,186	62.2

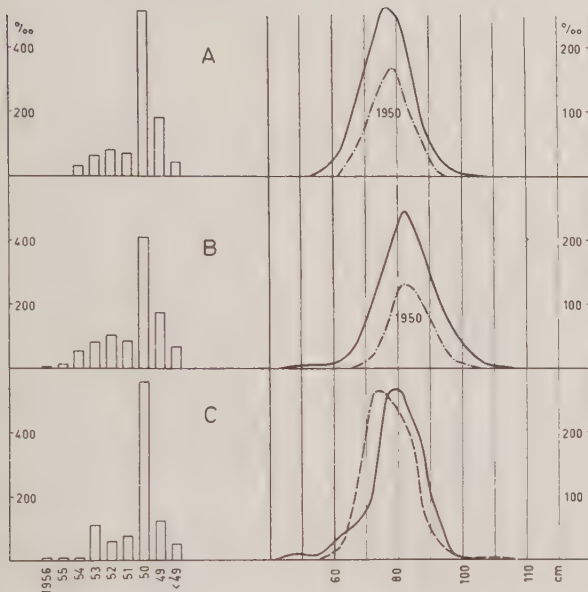


Figure 24. Age and length distribution (%/00) of cod from East Greenland.

- A. Cod from off Angmagssalik landed by trawlers in March and April 1959.
 B. Cod from Dohrn Bank landed by trawlers during August/December 1959.
 C. Cod from Cape Bille Bank landed by scouting trawler on 13. December 1959 (full line) and from Tordenskjold Bank (dashed line) landed by trawlers in March and April 1960.

While up to the present, the main fishery was carried out on the Dohrn Bank and off Angmagssalik, an increase in the fishery has occurred since 1959 on the difficult fishing grounds off south-east Greenland. Since the fisheries started, the same trend has been observed on all the fishing grounds, namely, only redfish were caught in the beginning, followed by a considerable decrease in the catches of redfish with a simultaneous increase in the proportion of cod. It is to be noted that this change only to a minor degree is the consequence of a change in fishing depth, but that the cod catches now also have increased at somewhat greater depths where originally only redfish were observed.

Contrary to the age composition of the West and South Greenland stocks only a small change has been observed in the East Greenland stock since

1958. The 1950 year-class is still predominant with 52% and a mean length of 78 cm in the spring catches from Angmagssalik (Fig. 24A), and with 41% and a mean length of 84 cm in the autumn catches from the Dohrn Bank (Fig. 24B). The proportion of the rich 1949 year-class has, however, decreased.

A research trip in December 1959 showed surprisingly favourable ice conditions off SE Greenland, and also an increased occurrence of cod, above all on the Cape Bille Bank. Figure 24C presents the age and length distribution of the catches taken on this bank (mean length 79.4 cm), and the length distribution of trawler catches from the Tordenskjold Bank (61°25'N) taken in March and April 1960. 70% of the cod caught there were mature. At the end of March, 25% of the mature cod were actually spawning or beginning to spawn. In a sample from 5. April 1960, 50% of the fish were spawners and 15% had almost finished spawning.

In mid-December, 115 cod were tagged off SE Greenland with yellow DHB tags with yellow flaps.

ARNO MEYER

Icelandic Stock

German Investigations

(Figures 25—26)

The German trawl fishery on Icelandic grounds is a mixed fishery for redfish, cod, saithe, and haddock. In 1953/1959 the landings of cod varied between 19,000 and 45,000 tons. The proportion of cod in the total landings amounted to 17.4—25.8% and was highest in 1955 (25.8%) and 1959 (25.0%). Most cod (51—82%) are caught from May to December off NW Iceland. In this fishery the proportion of cod during the last seven years has been 25—52%. On the spawning grounds off the SW coast only little fishing is carried out by German trawlers. The proportion of cod in this fishery (mainly for redfish) amounted only to 11—20%.

Figures 25 and 26 show the age and length composition of cod landed in the period 1953 to 1959 from SW and NW Iceland. The rich 1945 year-class predominated up to 1956 in the spring

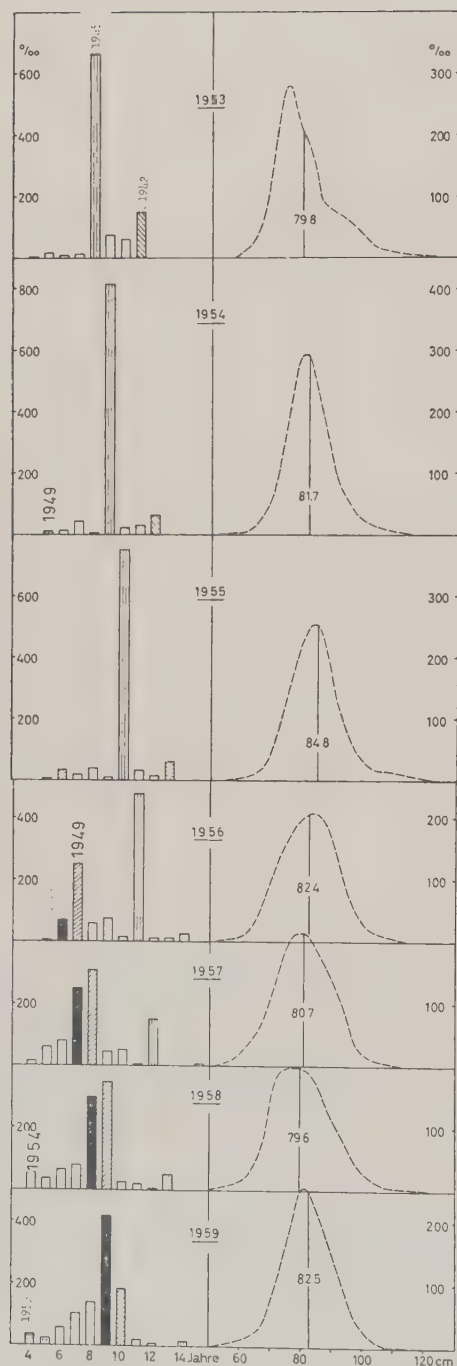


Figure 25. Age and length composition of cod landed from SW Iceland by German trawlers in the period 1953 to 1959.

fishery on the spawning grounds and has since 1957 been replaced by the next two rich 1949 and 1950 year-classes. Owing to differences in the average age of the spawning stock the mean length varied

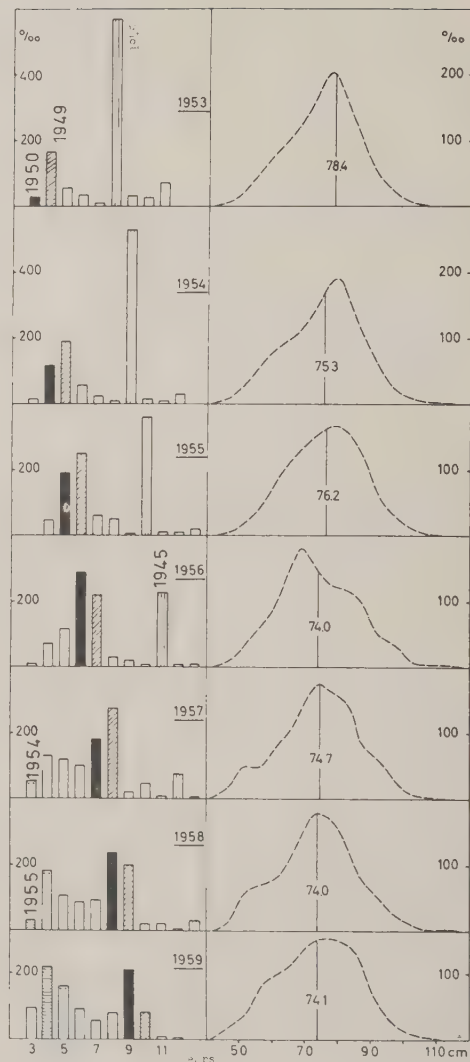


Figure 26. Age and length composition of cod landed from NW Iceland by German trawlers in the period 1953 to 1959.

between 79.6 cm (1958) and 84.8 cm (1955). In 1959, the 1949 and 1950 year-classes had reached a mean length of 85.9 cm and 83.1 cm respectively.

On the feeding grounds off the NW coast of Iceland the 1949 and 1950 year-classes entered the fishery in 1953 and 1954 and they were predominant in the landings from 1956 to 1958. In 1958 and 1959 two new year-classes appeared, those from 1954 and 1955. In 1959 they had reached an average length of 73.4 and 64.9 cm respectively.

In 1955 and 1959 the average catch of cod per fishing day off the NW coast rose to 8.5 tons and 6.6 tons respectively.

ARNO MEYER

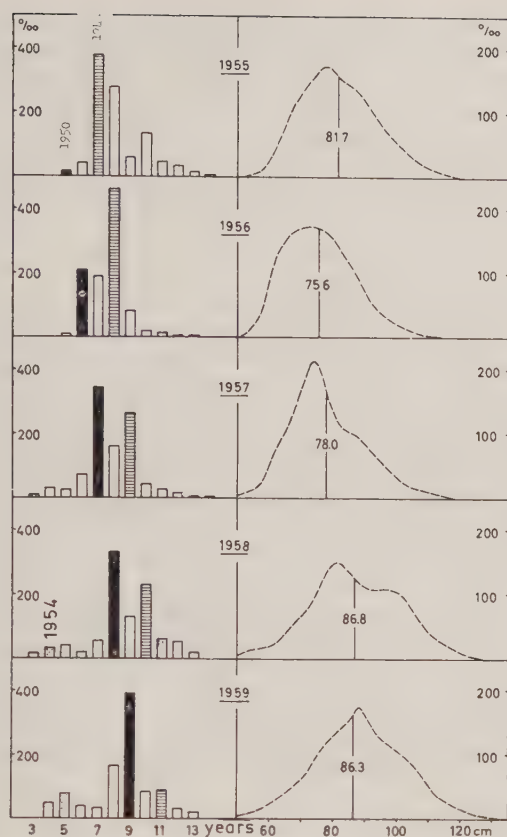


Figure 27. Age and length composition of cod landed by German trawlers in the period 1955/59 from the Norwegian coast.

Arcto-Norwegian Stock

German Investigations

(Figures 27-29)

The German fishery off the Norwegian coast is a mixed fishery. During the last 12 years (1948/59) the proportions of the four main species fished have totalled 34.2% of saithe, 22.9% of cod, 21.7% of redfish, and 15.5% of haddock. The proportion of cod varied between 33.7% (1948) and 13.9% (1954). This wide variation is mostly conditioned by the strength of the year-classes, but also by the availability of the three other species. In the period 1948 to 1959 the landings of cod ranged between 9,400 tons (1954) and 22,600 (1956). Most of these cod were caught in the first four months of the year off the Lofotens.

Figures 27 and 28 show the average catch of cod per fishing day from January to April in the period 1948 to 1959 and the age and length compositions of German landings from 1955 to 1959. The average

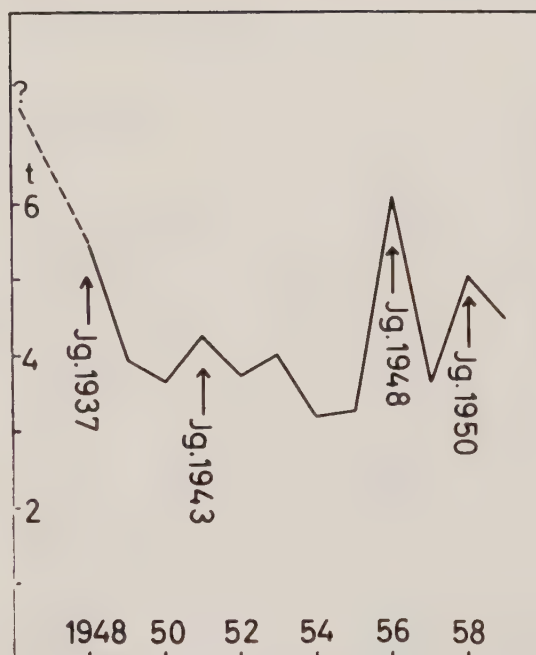


Figure 28. Average catch of cod per fishing day of German trawlers fishing off the Norwegian coast from January to April in the period 1948/1959.

catch per day during this period varied between 3.2 tons and 6.1 tons, it was lowest in 1954 and 1955 and highest in 1948, 1951, 1956, 1958, and 1959. The peaks in the curves correspond to the abundant year-classes of 1937, 1943, 1948, and 1950. It is noteworthy that the German landings always increase eight years after the birth of a rich year-class, that is, when the first large portion of a rich year-class becomes mature. The only exception was the year 1948, the first year of German fishery after the war. The good yields of that year were caused by the captures of big cod belonging to the rich 1937 year-class, which during the preceding years had given the highest yield to the Norwegian skrei fishery. But in those years no German fishery was carried out off the Norwegian coast.

Owing to the fact that the year-classes following the strong 1948 and 1950 year-classes were very weak, the average lengths of the cod landed rose from 75.6 cm in 1956 to over 86 cm in 1958 and 1959. The mean lengths of the two strongest year-classes in 1959 were 81.4 cm (1951) and 89.1 cm (1950).

Samples of ungutted cod taken in 1959 revealed the surprising fact that almost 30% of the cod, caught by German trawlers off the Norwegian coast consisted of immature fish. All the younger year-classes, most of which seem to be coastal cod,

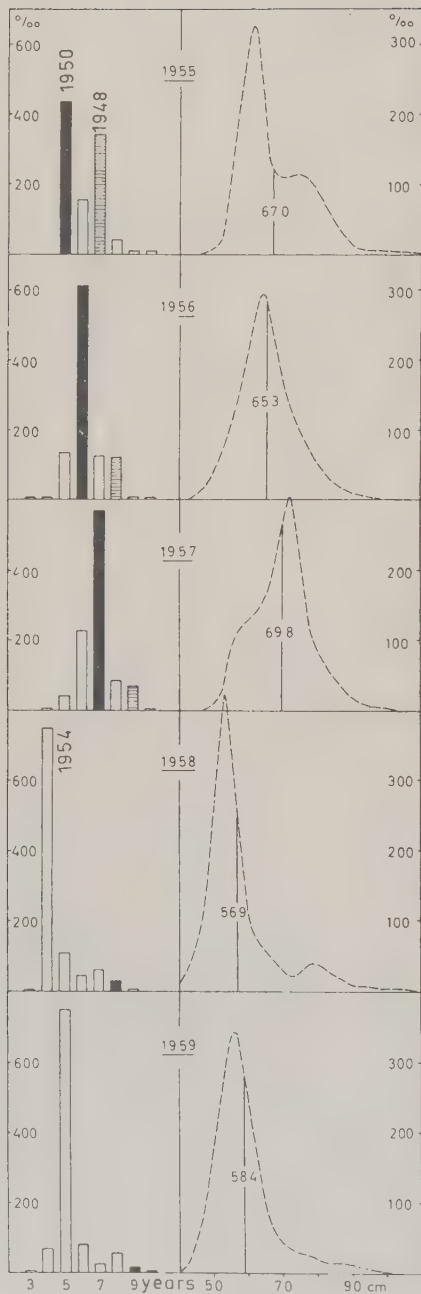


Figure 29. Age and length composition of cod landed by German trawlers from Bear Island and Spitsbergen in the period 1955/1959.

were juveniles. It was, however, interesting to note that only 75% of the 9 year-old cod (1950 year-class) were mature.

For studies of the type of otolith in the coastal cod, otoliths were collected in the autumn of 1959

for the first time from Malangen. The proportion of cod is only small in the landings from Malangen as the fishery is mainly for saithe and redfish. Age determinations showed that the 1955 year-class was predominant, providing 51%, followed by the 1956 class (23%) and the 1954 class (14%). The average length was 64.8 cm. The mean lengths of the three dominant year-classes were 56 cm (1956), 66 cm (1955), and 74 cm (1954).

The German fishery in the Bear Island and Spitsbergen area has been carried out on a reduced scale during the last 14 years compared with the years before the war. Now fishery will only be carried out when an outstanding year-class has reached at least six years of age and is providing good catches of medium to large cod. Thus German trawlers were only fishing in this area in the years 1946/47 (the 1937 year-class), 1949 (1943 year-class), and 1956/57 (1950 year-class). In 1956 when more than 60% of the cod belonged to the 1950 year-class (Fig. 29) the yield was highest with 25,236 tons. The poor year-classes which have appeared since the 1951 year-class, have caused a decline in the German landings from Bear Island, viz. only 171 tons in 1959. In future the German trawlers will make as few trawlings in this area as they have done for years in the Barents Sea.

ARNO MEYER

Baltic Stock

Polish Investigations in the South-Eastern Baltic in 1959

(Tables 18-19)

The spawning period of cod in the region of Gdansk Deep and Bay has followed a rather normal course as regards starting and duration, the density of the fish shoals during the prespawning and spawning period was, however, very poor. The results of exploitation were also poor and in spite of high intensity of fishing the yields could only be estimated at about 50% of those obtained during the best years (1951/52 and 1957).

The height of spawning was observed in April and May, the normal season being May and June. The proportion of spawning fish was somewhat higher than in 1958 but lower than the long-period mean (1955/1958) as shown in Table 18.

From the data set out in Table 18 it can be seen that a further decrease in the proportion of spawning fish in the catches has taken place during the two last years.

The spawning period in 1959 was very short, in June it was practically finished.

Table 18. The proportion of spawning cod (maturity stages VI and VII) in the Polish catches from the SE Baltic by weight (%)

Month	Year				
	1955	1956	1957	1958	1959
March	9.3	1.6	—	0.3	1.6
April	41.9	34.7	35.2	2.1	13.0
May	29.4	34.0	42.8	13.5	23.6
June	14.0	58.0	54.2	33.7	9.0

On the other hand, the ecological conditions for the spawning of cod were optimal, according to hydrographical and biological observations. The temperature of the near-bottom water layers was satisfactory. During spring the sunlight was strong, the development and quantity of plankton was rich, and the feeding conditions for larvae were fairly good. On the whole, in spite of the short and poor spawning season, the 1959 year-class might be quite strong.

The age composition of the Polish cod catches in 1958 and 1959 are given in Table 19.

Table 19. Age composition of cod by weight (%)

Year	Age-groups				
	I	II	III	IV	V
1958	0.2	9.5	30.5	25.5	21.6
1959	0.5	20.0	29.4	21.3	14.9

Year	Age-groups				
	VI	VII	VIII	IX	X
1958	8.6	2.0	0.6	1.2	0.3
1959	9.3	2.8	0.6	0.4	0.9

In 1959 the proportion of young cod (age-groups I and II) in the catches was extremely high, especially age-group II, which seems to indicate that the 1957 year-class is very strong. There was a small decrease in the proportion of age-groups III and IV, due to the very poor 1956 year-class and the average value of the 1955 year-class. On the other hand, the increase in the proportion of older fish was noticeable owing to the very strong 1953 and 1954 year-classes and maybe also the 1949/50 year-classes (age-groups V—X).

The percentage length composition of the catches in 1959 fully confirms the above data.

The complex observations allowed to forecast for 1960 a general improvement of the conditions for the stocks of cod in the SE area of the Baltic and thus better results of the fishery.

ST. RUTKOWICZ

Danish Investigations on Cod in the Bornholm Region
(Figures 30—32; Tables 20—23)

The oxygen content in the lower layer of the Bornholm basin was high and the cod were distributed over the whole area, in contrast to previous years.

The length distribution in 17 hauls made in August 1959 with the standard trawl around Bornholm in 35—96 m depth is shown in Table 20 and the age composition in Table 21. The 0-group dominated the catches, and there is no doubt that the unusually strong 1959 year-class derives from the strong inflow of saline water and the high summer temperatures. Actually, the numbers of this year-class in relation to the other age-groups were still larger than appears from the tables because an 18 mm mesh was used in the cod-end and therefore many fish of less than 10 cm length escaped through the meshes (as in 1957).

The 1958 year-class occurred in much larger numbers than might have been expected from the small numbers of 0-group cod found in 1958. They must have immigrated from other areas and it is quite possible that a great number has been borne in from the Belt Sea and the Kattegat with the strong inflow of saline water. The rich 1957 year-class, the II-group, with a mean length of 29 cm, was present by about 50% of the numbers in 1958.

Table 20. Length distribution ($^{\circ}/_{00}$) of cod in Danish catches at Bornholm

(The lengths measured to the nearest lower whole cm)				
cm	1951—56	1957	1958	1959
5—9	55	346	8	357
10—14	73	160	145	124
15—19	229	1	295	199
20—24	161	30	169	124
25—29	138	112	47	61
30—34	116	147	42	60
35—39	86	94	78	36
40—44	61	57	92	16
45—49	39	35	68	8
50—54	23	10	35	6
55—59	10	2	9	3
60—64	4	2	6	2
65—69	4	2	3	2
70—74	—0	1	1	1
> 75	—0	0.4	1	0
Total	999	999	999	999

Table 21. Numbers per 5 hours' haul with the standard trawl in Danish catches at Bornholm
(preliminary figures)

Age-group:	0	I	II	III	IV	V	VI+Total
1957	195	1	70	78	35	3	383
1958	5	1005	60	170	70	2	1314
1959	1492	1040	436	68	81	6	3138

Table 22. Length of the age-groups (cm) in Danish catches at Bornholm
(preliminary figures)

Age-group	1950-56	1957	1958	1959
I	—	—	17.9	19.4
II	26.8	28.4	27.1	28.9
III	35.3	33.9	40.6	37.6
IV	46.5	43.7	48.2	47.4

The rich 1955 year-class was also reduced in numbers but much less than might have been expected. The extensive migrations of the cod in the Baltic (see tagging experiments, below) makes it impossible to establish the reduction of a single year-class from one year to the next. In calculating the annual mortality rate it is necessary to use the mean value for a series of years.

The average lengths of the age-groups are shown in Table 22.

Tagging experiments in the Baltic

Tagging experiments were carried out between 12. and 16. March 1959 SSE and SE of Neksø (Fig. 32) in fine weather. The method used was described in last year's *Annales*, p. 105. In each haul rather small catches of cod were taken and all the fish were tagged very soon after capture. Therefore the rate of recapture has been almost equal whether cod from a certain haul were tagged at first or at last, in contrast to the results of 1958. (At the top of p. 106 of *Ann. Biol.*, 15, in the table showing the few recaptures of the lastly tagged cod a disturbing misprint has occurred in that "year" should read "part".)

From the figures given in *Ann. Biol.*, 15, p. 105 it may seem that cod which apparently were fully vital but had small damages as abrading of some few scales, scratchings, or small wounds from the trawl, gave much less recaptures than the undamaged fish. In 1959, 55 of such slightly damaged cod were tagged and 25 of these, or 45%, were recaptured as against 40% of those which were not

visibly damaged. Without doubt the cod were less damaged by the trawl in the relatively small catches taken in 1959 when the wind was only 2—3 Beaufort, than in the larger catches made in 1957 when the force of the wind was in the region of 4—6 during the tagging experiment and a heavy swell prevailed in the days with less wind, and in 1958, when the force of the wind was in the region of 4, the swell was heavy, and the air temperature mostly below zero and that of the surface water between 0.0 and 0.5°C.

Recapture percentages and comparison of tags

The recoveries received or reported until May 1960 are compiled in Table 23. Many recaptures from other countries have been delayed in being reported and therefore some of the figures in Table 25 on p. 105 in *Ann. Biol.*, 15 have to be changed. For the same reason some of the figures in Table 23 may also be changed.

It should be remembered that the number of months elapsed since tagging are for the years 1957, 1958, and 1959 38, 26, and 14 respectively, and therefore some more recaptures may be expected from the 1959 experiment.

From Table 23 it is seen that the percentages of recaptures are much greater in the 1959 experiment than in those of 1957 and 1958 in which they were 20 and 17 respectively. No doubt this is partly due to better tags, especially the application of braided nylon instead of full nylon for fastening the alcathe tags, but in my opinion it is mainly due to better weather conditions during the tagging experiment.

The 1957 experiment seemed to show that the blue alcathe tags were inferior to the red ones; the 1959 experiment show, however, the same recapture percentages for both colours and thus they actually seem to be equally good.

Table 23. Number of cod tagged at Bornholm with the different types of tags and number and percentage recaptured

	Number tagged	Number recaptured in months after tagging								Percentage recaptured		
		1	2	3-4	5-8	9-12	13-18	19-24	25-30	First year	Second year	Third year
1957, March												
Alcathe	148	10	9	2	6	3	5	3	1	20	5	1
1958, March												
Alcathe	292	15	9	3	8	3	4	0	?	13	1	—
Lea	109	12	4	2	7	4	1	0	?	27	1	—
1959, March												
Blue alcathe	71	10	12	6	2	1	?	?	?	41	—	—
Red alcathe	122	19	16	10	2	1	?	?	?	39	—	—
Lea	197	38	17	13	8	1	(2 ?)	?	?	39	—	—

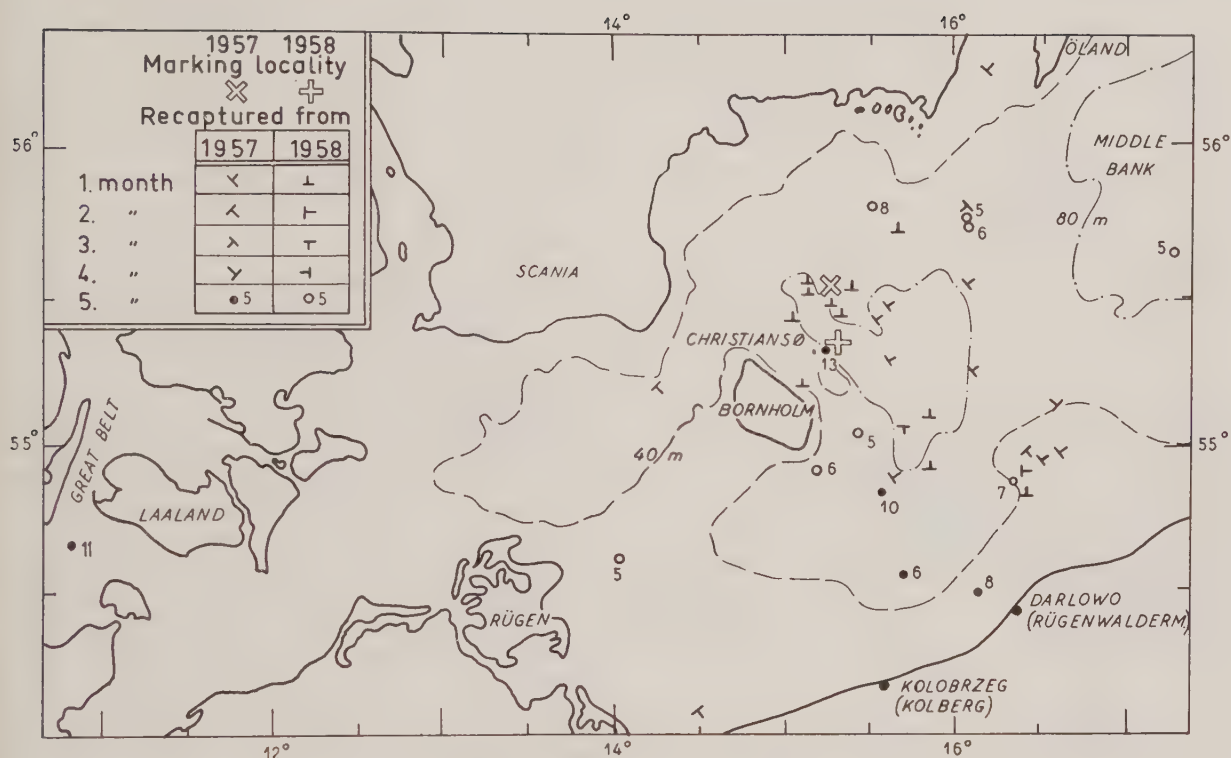


Figure 30. Danish cod tagging experiments at Christiansø in 1957 and 1958.

Calculation of mortality rate

No further recaptures than those shown in Ann. Biol., 15: 105 have been reported from the taggings with button tags in 1957. The number of recaptures is so low that this tagging method has been excluded from the calculations of mortality.

In 1958 some of the alcatheene tags were fixed with thin, full nylon threads which were very loosely twined (see Ann. Biol., 15: 104), but until now they have given 11% recaptures against 15% of the other alcatheene tags, and thus they seem to be equally good.

From the 1957 and 1958 experiments taken together the following recaptures have been reported:—

Number tagged		Recaptured in		Total mortality
		first year	second year	
Total	550	98	13	87%
27 not well twined excl.	523	95	13	86%
46 damaged excl.	477	83	12	86%

In the third year after liberation one recapture has been reported from the 1957 tagging experiment and in this case also the total annual decrease is of the same order of magnitude.

From the number of the various age-groups caught per hour at Bornholm with the standard trawl the total annual mortality of the age-groups between III and VII has in recent years been estimated at 79% (see Rapp. Cons. Explor. Mer, 147: 17. 1959). The tagging experiments in 1957 and 1958 thus show nearly the same figure for the total annual reduction of the stock as had been estimated from the quantitative fishing.

The percentage recaptures in the first year after the liberations in 1957 and 1958 may be remarkably much lower than the actual fishing mortality on account of the bad weather conditions during the experiment; the 40% recapture from the 1959 experiments gives of course also a too low value due to the tagging mortality, the loss of tags, and the recaptures not recorded.

Recaptures of cod tagged at different length

In the 1957 and 1958 experiments these recaptures were fewer as to the smallest and largest fish than to those of about 50 cm length (see Ann. Biol., 15: 105, the recaptures reported later on has not altered this difference). The 1959 liberations show the same picture:—

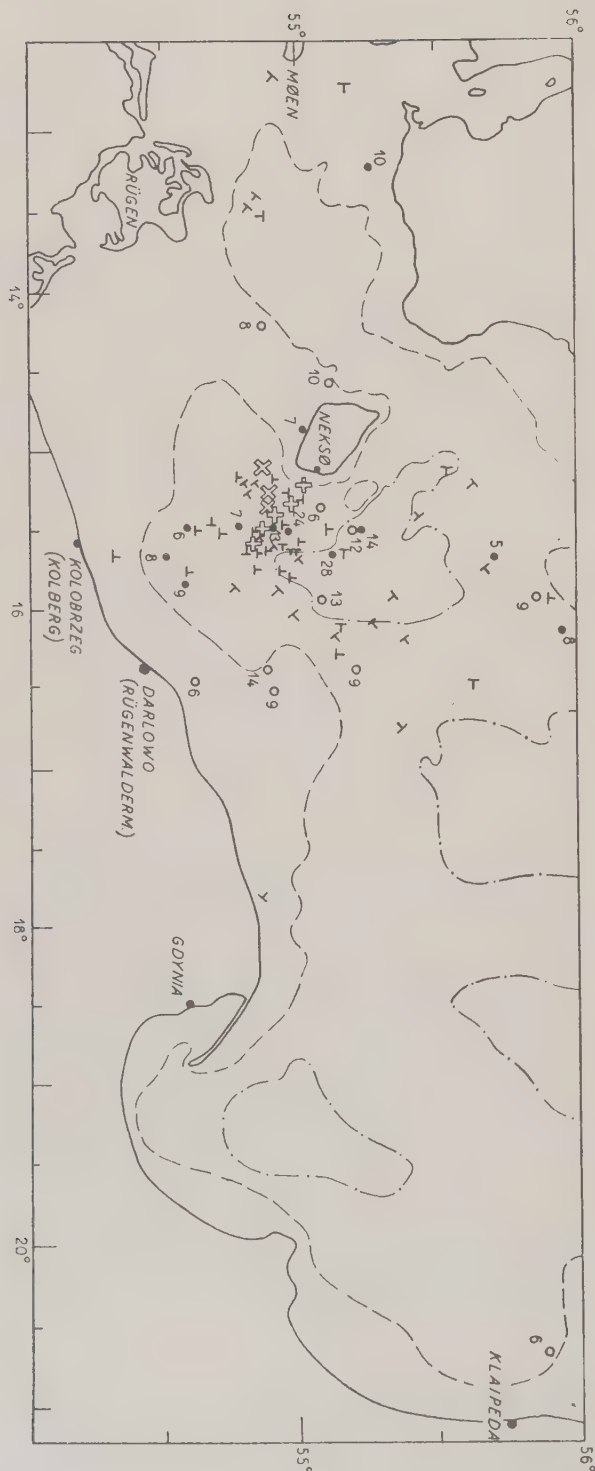


Figure 31. Danish cod tagging experiments south and south-east of Neksø, Bornholm, in 1957 and 1958. Symbols as in Fig. 30.

Length at tagging cm	Number tagged	Number recovered	%
22—29	18	1	6
30—39	22	5	23
40—49	133	54	41
50—59	135	67	50
60—69	63	24	38
70—79	17	7	37
80—94	2	0	
Total	390	158	41

Most cod in the Baltic are fished in the prespawning and spawning period when they concentrate in the "deeps". In the stocks on the Polish fishing grounds, investigated by RUTKOWICZ (Rapp. Cons. Explor. Mer, 147: 52. 1959) about 20% II-group cod of about 32 cm length were mature in the spring, but almost 100% III-group fish of about 40 cm length were mature. In the whole stock the percentage of mature fish belonging to these age-groups may be somewhat less because part of the immature cod will not stay on these grounds; they will visit them more or less accidentally but they spend most time at more shallow depths on stony grounds where the fishing intensity is less; thus they are not so exposed to recapture as the mature cod which stay most of the spring and summer in the "deeps". The small cod are also more exposed to lethal inner damage caused by trawling and tagging. When placed in the tub immediately upon capture it is evident that the smallest cod are not capable of living and many of those which apparently are viable may die soon after liberation.

The low percentage of recaptures of large cod (now also confirmed by the 1959 taggings) may be caused by their greater ability to avoid the trawl due to their greater swimming power, the explanation may, however, also be that they live in the pelagial and spend only a shorter period in the "deeps". Whatever the explanation is, this phenomenon is of great biological and practical interest because the total mortality is almost equal for all age-groups after maturity is reached (see AA.J.C. JENSEN, Rapp. Cons. Explor. Mer, 110, 1939). Their lesser fishing mortality must be counterweighted by a greater natural mortality.

Migrations

The localities of tagging and recapture are shown in Figures 30—32.

Most of the cod were recaptured in the first four months and in the 13. to 17. month after tagging (April/July) and were caught near the tagging locality. A few fish had undertaken remarkably long migrations in a very short time. The recaptures taken in the 5. to 7. and 17. to 19. month after

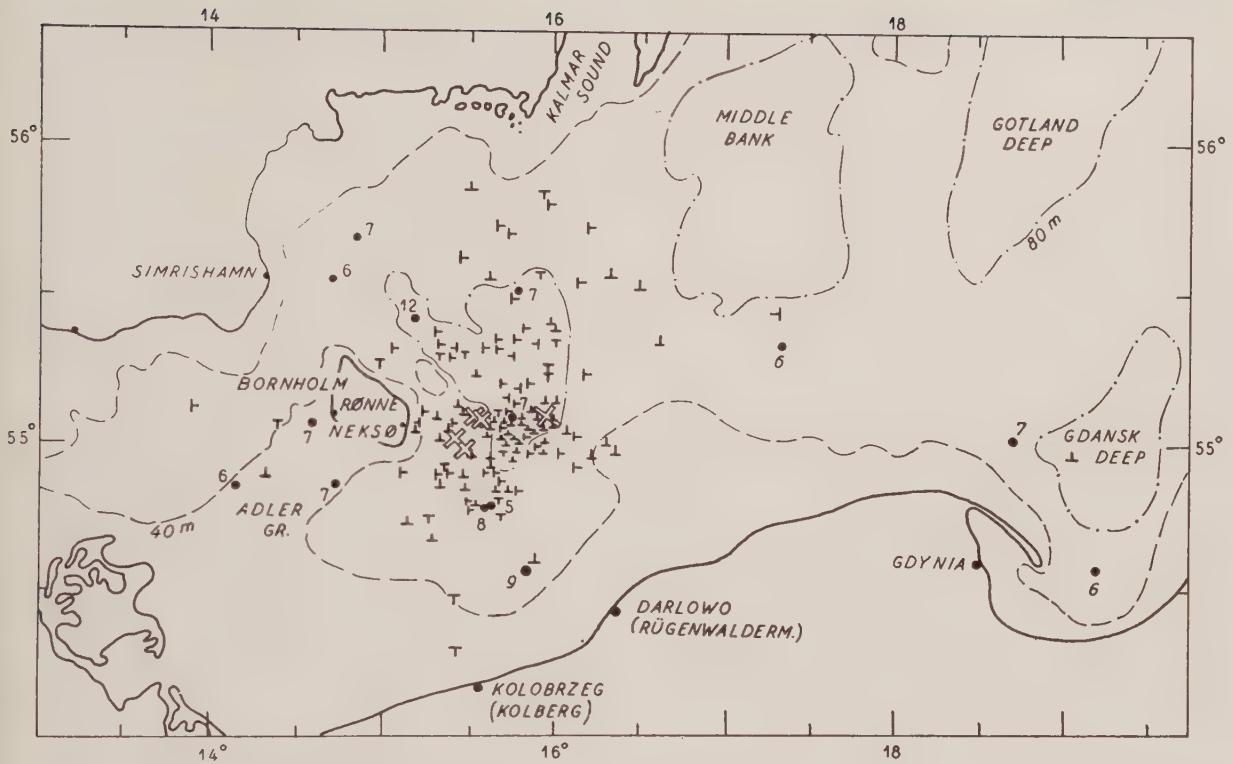


Figure 32. Danish cod tagging experiment south-east and east of Neksø in 1959. Open crosses indicate localities of tagging. Symbols for recaptures as for the 1958 experiment, see Fig. 30.
One recapture in the 11. month after tagging taken in the northern Great Belt.

tagging (August/September) were chiefly located at the edge of the cluster of recaptures (April/July) but some fish were caught far away from the place of liberation, thus one in 1958 off Klaipeda. The recaptures in the 8. to 10. month (November/December) were mostly taken at a great distance from the tagging locality. Most of the fish recovered in August/December were caught at shallower depth than where they had been tagged. The cod recaptured 11—12 or 23—24 months after tagging were mostly taken near the place of liberation or at least in the Bornholm basin, but two were recaptured at the southern entrance to the Great Belt and in the northern part of the Great Belt respectively.

It is noticeable that there is no definite tendency to migrate in any distinct direction, most strikingly contrasting to the results of the Polish investi-

gations which show a very marked tendency to migrations from off Gdansk to the Bornholm basin or to the east of Bornholm (RUTKOWICZ, loc. cit. 1959: 54, and NETZEL, Ann. Biol., 15: 108). Our results are also in contrast to those of the Swedish tagging experiments in which most of the recaptures were made in the southern Baltic between Rügen/Bornholm and Klaipeda/Gotland (see OTTERLIND, Rapp. Cons. Explor. Mer, 147: 66. 1959).

The most important result of the tagging experiments is that there is a strong mixing between the cod stocks in the different parts of the Baltic proper which shows that the measures for rationalization of the exploitations of the cod stocks ought to be the same all over the Baltic proper.

AAGE J. C. JENSEN

Table 24. Distribution of cod in the central Baltic in 1958/59 by maturity stages

Year	Area	Maturity stages (%)				VI
		I-II	III	IV	V	
May						
1958	Liepaja	8.0	14.0	54.0	24.0	—
1959	Liepaja	93.0	7.0	—	—	—
1958	Ventspils	4.1	15.7	5.0	0.1	2.1
1959	Ventspils	98.0	2.0	—	—	—
June						
1958	Liepaja	10.0	1.0	1.0	16.0	12.0
1959	Liepaja	85.0	12.0	3.0	—	—
1958	Ventspils	1.0	—	—	6.0	93.0
1959	Ventspils	93.0	3.0	—	1.0	3.0

Distribution and Age Composition of Cod in Gothland Deep in 1959

(Tables 24-25)

During the last four years the following changes in salinity and oxygen content have been observed in Gothland Deep: in 1955 the 11‰ isohaline was observed at a depth of 85 m and the 18‰ isoxylene below 130 m; in 1957 the 11‰ isohaline went down to 95 m and the 18‰ isoxylene rose to 105 m; in 1958/59 the 11‰ isohaline was observed at 110 m and the 18‰ isoxylene at 90 m depth.

As a result of these changes the cod spawning area in Gothland Deep was by 1957 much reduced in size, and in 1958 and 1959 almost no spawning took place in this area. In 1959 the whole cod spawning area in the Baltic constituted not more than 30% of what it had been in 1953/55. In January/March 1959 prespawning cod kept to a narrow stretch of 80—95 m. In 1959 the main part of the spawning concentrations left Gothland Deep for the areas situated farther to the south and west. This was confirmed both by the results of tagging experiments and by analyses of the dynamics of the catches in various areas of the Baltic, as well as by studies of the distribution of the stocks.

Table 25. Age composition of cod from trawl catches taken in the area of Gothland Deep during the first half of 1959

Years/Age	2	3	4	5	6	7	8	9	Total
1959	4.6	7.2	29.0	40.0	14.0	3.6	1.6	—	100.0
1953-59	3.0	21.9	41.2	41.2	22.6	8.5	3.0	1.1	

Only young, immature cod were observed during the spawning period in the northern and central parts of Gothland Deep. Large, mature cod were almost entirely absent in the Gothland/Ventspils area in January/February 1960; the fish were wintering farther to the south and west of this area (in contrast to previous years when cod after spawning returned to this area).

Table 24 shows the more extensive spawning migrations of cod from the central Baltic to the south-western areas in 1959 compared with the previous year.

Thus the spawning conditions for cod in the Baltic have considerably deteriorated and this should affect the abundance of the stocks.

Changes in the age composition of the commercial stock of cod in the central Baltic are shown in Table 25.

From the figures in Table 25 it may be seen that the recruitment was relatively poor in 1959. A further decrease in the stocks of cod may be expected in 1960/62 since the recruitment to the commercial stock will come from either medium or poor year-classes. Consequently, the catches of cod in this part of the Baltic will be lower than in the previous years.

It is, however, expected that the 1957 year-class will be of moderate abundance judging from the quantitative estimates.

I. A. LABLAIKA

HADDOCK

Icelandic Stock

German Investigations

(Figure 33)

The proportion of haddock contained in the German trawler landings from the Icelandic fishing grounds is only small and amounted in 1953 to 2.4% and in 1957 to 6.94% of the total catch. These 3,200 to 7,300 tons were mostly caught during the spring fishery (especially in April) off the SW coast. The proportion of haddock in the

landings from SW Iceland rose from 2.3% in 1953 to 8% in 1956, 9.5% in 1957, and 7.0% in 1958.

The age and length composition show that the increase in haddock landings was due to the three successive rich year-classes of 1949/1951. The 1951 year-class seems to have been the strongest, predominating from 1956 to 1958, the years with increased yields of haddock and the highest figures for the catch per fishing day.

In 1959 the landings dropped to 50% of those of 1958. The age composition revealed a sharp

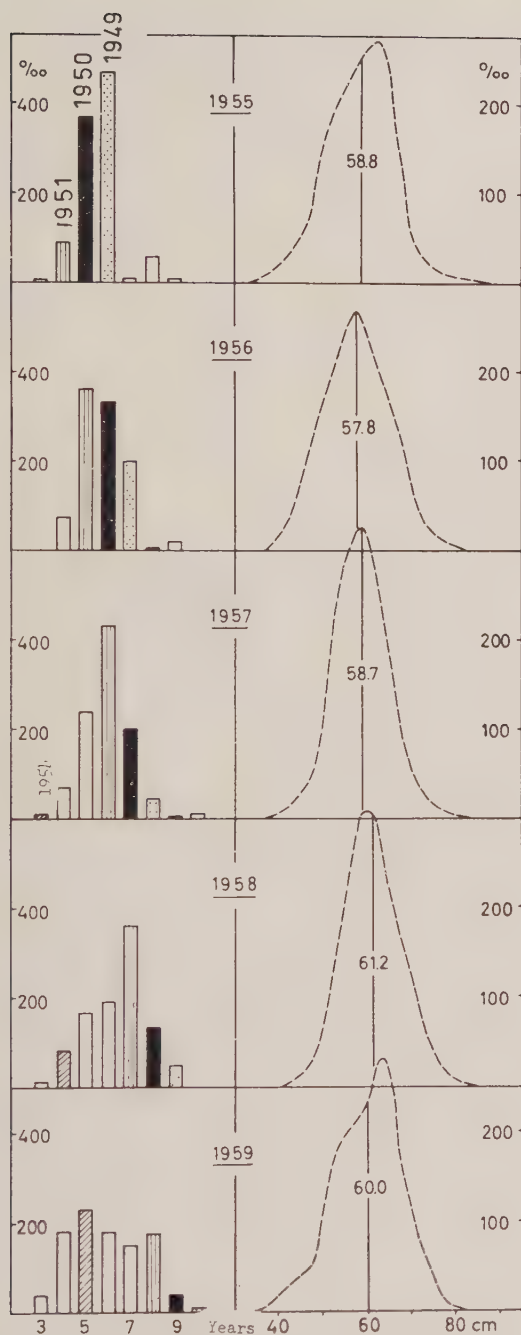


Figure 33. Age and length composition of haddock landed by German trawlers from SW Iceland in 1955/1959.

decrease of the 1951 year-class and the dominance of the younger 1953 to 1955 year-classes.

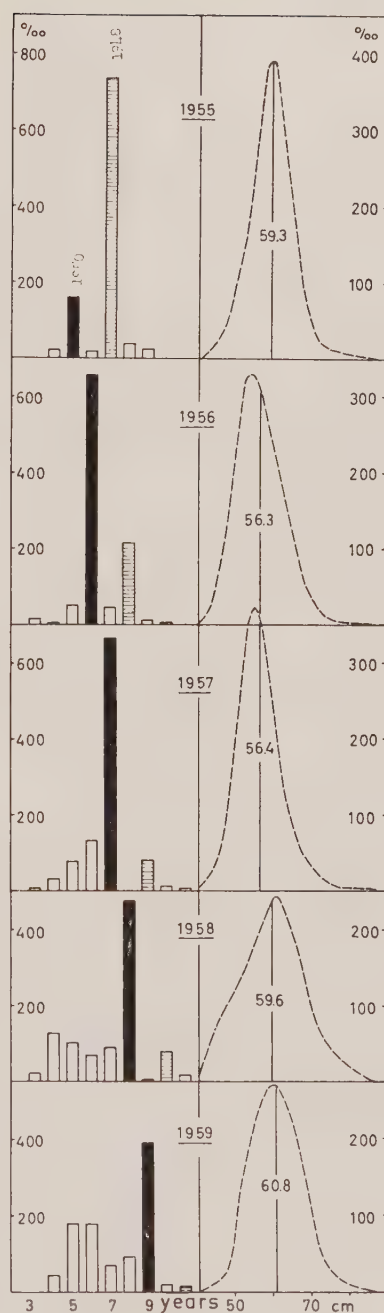


Figure 34. Age and length composition of haddock landed by German trawlers from the Norwegian coast in 1955/1959.

The average length of the four best year-classes 1951, 1953, 1954, and 1955 was 64.0, 62.8, 59.3, and 52.1 cm respectively.

ARNO MEYER

Arcto-Norwegian Stock

German Investigations

(Figure 34)

Nearly all haddock landed from the north-eastern region by German trawlers are fished during the season January to May off the Norwegian coast. With 12,513 tons in 1955 and 18,112 tons in 1956 the two outstanding 1948 and 1950 year-classes (Fig. 34, p. 147) gave rise to the highest yields of large haddock since German fishery off the Norwegian coast was started in 1934. In March 1955 and 1956, the average daily catch rose to 8 tons.

At present the haddock catches are decreasing, whilst the mean length in 1959 reached the highest level since 1955 with 60.8 cm. The average length of the 9 year-old haddock which still provided 39% of the total landings was 64 cm. The 1950 year-class was followed in strength by the 1953 and 1954 year-classes which were equal (18%). Their mean length was 58.3 cm and 54.7 cm respectively.

ARNO MEYER

Soviet Investigations on Small Haddock
of Age-Groups 0—III

(Tables 26—28)

As in previous years, a quantitative analysis of the small haddock was made in the Barents Sea during the winter of 1958/1959 by the scientific workers of the Polar Institute. In Table 26 the results of this analysis are shown. The greatest number of small haddock occurred in the coastal waters where the 1956 year-class was predominant. In the western areas haddock belonging to this year-class were also abundant (30 fish per 1 hour's trawling). The haddock of the 1957 year-class were less abundant (22.2%), but in the coastal waters the catches per 1 hour's trawling were substantial. The 1958 year-class was found to be very weak. Over the whole area 1 hour's trawling yielded only 2 0-group specimens. The 1959 year-class is considered to be poor.

Table 27. Mean catches (number of fish per 1 hour's trawling) of haddock of the different year-classes in the western, central, and coastal areas during the winter

Year-classes	Results of the quantitative analysis				
	First year	Second year	Third year	Fourth year	Mean of second and third years
1946	<1	—	1	3	1
1947	—	<1	1	<1	1
1948	5	32	26	13	30
1949	3	1	11	2	7
1950	80	247	262	87	256
1951	22	19	12	12	15
1952	8	5	10	4	7
1953	11	40	25	10	31
1954	10	7	3	3	5
1955	8	3	2	3	3
1956	26	18	27		23
1957	38	9			
1958	2				

Table 28. Mean catches (number of fish) of 0-group haddock of the different year-classes by areas in the southern part of the Barents Sea during winter

Year classes	Central elevation area				
	Central areas	Western areas	Coastal areas	Eastern areas	
1950	23	42	216	108	—
1951	?	10	?	100	—
1952	13	4	9	21	
1953	2	6	26	8	1
1954	23	5	12	17	4
1955	<1	1	15	9	<1
1956	4	1	55	22	<1
1957	37	22	62	6	<1
1958	<1	1	3	4	<1

As appears from the comparison of the mean catches of small haddock belonging to the different year-classes with the data over several years (Table 27), the 1956 year-class might be considered rich. The 1957 year-class, estimated as 0-group fish, appeared to be a good one (38 specimens per 1 hour's trawling). This result is higher than those of other year-classes, except the very abundant 1950 year-class. The 0-group of this year-class as well as that of other strong year-classes (1950, 1953, 1956) was predominant in the western areas of the

Table 26. Mean catches (number of fish) of young haddock of different age per 1 hour's trawling in the southern part of the Barents Sea from November 1958 to March 1959

Areas	Number of trawlings	Age and year-class				Total	Total number invest.
		0 + (1) 1958	1 + (2) 1957	2 + (3) 1956	3 + (4)* 1955		
Central	65	1	2	5	<1	8	519
Western	69	3	6	30	4	43	3,001
Coastal	16	4	54	105	5	168	2,698
Total/Mean	150	2	9	27	3	41	6,218
% of the total		6.2	22.2	65.2	6.4		

* This group embraces only the specimens below 36 cm in length.

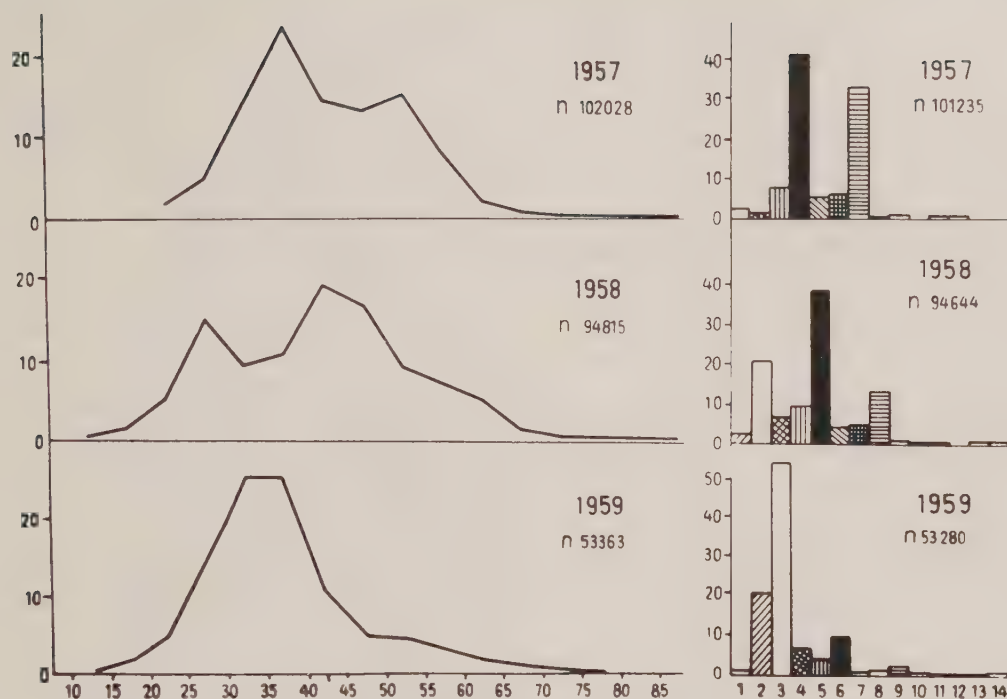


Figure 35. Length (left-hand side) and age (right-hand side) composition of haddock in the southern part of the Barents Sea.

sea. However, an analysis of the 1957 year-class as II-group fish showed a considerable decrease of the number of fish in the catches (Table 26), we are therefore considering it of medium strength. It is noticeable that this year-class as 0-group was transported in great numbers to the central elevation area. The latter circumstance is connected with the relative rise in 1957 in the water temperature of the northern branch of the warm current which passes across this area. According to data available the poor 1952 and 1954 year-classes were also as 0-group fish transported in great numbers to the central elevation area. The transport to the central elevation area of the 0-group of the 1950 year-class is not important in view of the fact that small fish of this year-class were widely distributed both in the southern and north-western areas.

A. S. BARANENKOVA

Soviet Investigations on Year-Class Strength of Haddock

(Figures 35–36; Table 29)

The length and age composition of the haddock in the southern part of the Barents Sea was investigated in 1959 by the scientific workers of the Polar Institute from the R/V "Tunetz" and "Persey-II" and during special trips of the reconnaissance trawlers.

Furthermore the members of the Polar Institute made observations on the length/age composition of the haddock on the Röst, Vesterålen, and Malangen Banks where R/V "Sevastopol" and reconnaissance trawler "Melitopol" operated from January to May.

The length and age composition of the haddock in the southern part of the Barents Sea is shown for the last three years in Figure 35.

In 1957 the haddock of the 1950 and 1953 year-classes were predominant, and in 1958 the 1953, 1950, and 1956 year-classes provided the greatest yields. According to our data the most abundant year-classes in 1959 were those of 1956 and 1957. The strength of the 1953 year-class was declining. The analyses of length and age composition showed that the same year-classes were predominant in

Table 30. Aberdeen trawlers' market samples — Faroe haddock 1959

A. Number landed per 10 hours' fishing												
Brood	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1958	—	—	—	—	—	—	—	—	—	80	111	349
1957	18	3.0	—	17	78	214	619	322	459	469	732	732
1956	554	351	207	671	371	480	1,031	716	232	188	246	309
1955	156	200	291	527	230	162	252	218	93	51	62	55
1954	77	106	129	298	84	66	138	77	26	24	28	26
1953	70	50	94	213	65	92	140	63	30	14	30	23
1952	14	13	13	30	13	32	36	13	8.7	2.9	10	7.4
1951	9.0	4.0	6.7	11	7.7	15	18	5.0	4.1	0.7	5.8	2.2
1950	2.0	3.0	3.4	4.5	2.6	11	7.8	1.4	2.0	0.7	2.8	0.8
1949	1.0	2.0	0.8	1.5	0.7	6.0	2.0	0.9	0.5	0.3	0.4	0.4
1948 and older	—	—	0.4	0.4	—	0.9	1.2	0.3	0.2	0.1	—	—
Total	901	732	745	1,773	852	1,079	2,245	1,417	856	831	1,228	1,505
B. Mean lengths of each age-group sampled												
1958	—	—	—	—	—	—	—	—	—	32.1	31.9	32.7
1957	33.0	33.0	—	31.4	32.7	33.9	33.8	33.6	35.0	37.1	37.8	37.8
1956	39.1	37.4	38.6	39.7	39.0	40.4	40.6	39.0	42.9	44.7	45.6	45.7
1955	46.8	45.1	45.1	46.4	45.9	46.6	46.8	44.9	47.6	49.1	50.7	50.0
1954	51.4	48.7	49.8	50.8	51.9	53.2	50.7	50.4	55.2	52.0	55.3	54.8
1953	56.4	54.9	54.3	54.9	55.9	56.8	56.2	56.3	58.6	55.8	60.9	59.2
1952	63.1	62.3	62.1	61.7	62.8	63.8	62.6	61.8	61.8	64.7	66.1	66.1
1951	66.7	67.0	64.9	65.3	64.0	66.4	68.3	67.1	68.4	70.0	68.2	68.6
1950	70.4	67.4	70.0	69.7	68.7	68.9	69.0	70.0	67.7	69.2	70.5	72.7
1949	73.9	67.8	70.1	68.1	71.4	70.1	70.1	69.3	70.8	74.3	72.0	70.0
1948	—	—	78.0	71.4	—	72.2	77.0	74.0	72.0	74.0	—	—
C. Estimated ¹⁾ weights landed per 10 hours' fishing (cwt.)												
1958	—	—	—	—	—	—	—	—	—	0.44	0.60	2.00
1957	0.10	0.02	1.82	0.08	0.43	1.34	3.93	2.02	3.27	4.04	6.67	6.54
1956	5.44	2.85	4.04	6.55	3.54	5.26	11.57	7.17	3.09	2.92	4.05	5.07
1955	2.68	2.99	2.39	8.20	3.56	2.72	4.40	3.37	1.71	1.03	1.42	1.19
1954	1.79	2.02	2.28	6.20	1.85	1.68	3.03	1.71	0.78	0.59	0.86	0.77
1953	2.13	1.35	0.50	5.50	1.82	2.81	4.30	1.97	1.05	0.41	1.21	0.83
1952	0.62	0.52	0.28	1.08	0.54	1.41	1.50	0.55	0.36	0.13	0.48	0.35
1951	0.49	0.19	0.17	0.48	0.32	0.68	1.00	0.26	0.23	0.04	0.31	0.12
1950	0.13	0.15	0.04	0.26	0.13	0.64	0.45	0.08	0.11	0.04	0.18	0.05
1949	0.07	0.10	0.01	0.08	0.04	0.37	0.12	0.05	0.03	0.02	0.03	0.02
1948 and older	—	—	0.02	0.03	—	0.06	0.09	0.02	0.01	0.01	—	—
Total	13.45	10.19	11.55	28.46	12.23	16.97	30.39	17.20	10.64	9.67	15.81	16.94
Actual landings per 10 hours by Aber- deen trawlers	14.14	10.39	11.60	27.50	11.35	15.39	29.01	16.77	10.30	9.63	15.53	16.29

¹⁾ Estimated using data from RUSSELL, 1914.**Faroe Stock****Scottish Investigations**

(Tables 30-31)

Market sampling of the Faroe haddock stock has been continued as in previous years and the data are given in Table 30.

Age composition

The age composition of the haddock sampled from commercial trawlers is shown in Table 30A. The mean lengths of each year-class are given in Table 30B, and in Table 30C are shown the estimated weights of each year-class landed per 10

hours' fishing each month. These were determined by converting the mean lengths in Table 30B to weights (using data from RUSSELL 1914*), and then multiplying each by the appropriate numbers per 10 hours' fishing from Table 30A.

As in previous years the younger age-groups (II—VI) made up the greater part of the landings. There was also the usual tendency for the mean lengths to decrease during the spring, although this year the decrease was most pronounced from January to February instead of from March to April.

*) RUSSELL, E. S. (1914) Fish. Invest., Lond., Ser. 2, 1 (1).

Table 31. Landings of three size categories by Aberdeen trawlers from Faroe 1959

Month	Cwt. per 100 hours				
	Hours fishing	Large	Medium	Small	Total
January ...	3,756	29.5	50.9	61.1	141.4
February ..	5,349	31.8	35.9	36.2	103.9
March	7,665	32.7	44.7	38.7	116.0
April	4,087	61.6	116.7	96.7	275.0
May	3,915	26.2	34.3	53.1	113.5
June	11,515	43.1	40.8	70.0	153.9
July	11,723	74.7	95.4	120.0	290.1
August	7,569	41.2	41.3	85.2	167.7
September .	7,029	20.1	41.9	41.0	103.0
October ...	6,459	16.5	32.5	47.3	96.3
November .	5,900	23.7	49.1	82.5	155.3
December .	5,640	23.1	58.7	81.1	162.9
Total/Mean	80,607	38.3	54.1	70.9	163.4

The average weights of haddock landed per 100 hours' fishing by Aberdeen trawlers from Faroe during 1958 are shown in Table 31. The mean catch during 1959 of 163.4 cwt. continues the decline in landings that commenced when the catch per unit fishing effort began to decrease in 1958.

R. JONES

North Sea Stock

Scottish Investigations

(Tables 32-36)

Age composition

During 1959 F.R.S. "Scotia" completed one routine trawling survey in the North Sea in October. F.R.S. "Explorer" completed three surveys of the Moray Firth in March, June, and November, and two comparative fishing cruises, one in April and one in December. The age compositions of haddock captured for 10 hours' trawling by these ships are shown in Tables 32 and 33. The very good 1955 year-class is still very much in evidence in all areas. Also, the scarcity of the 1956 and 1957 year-classes is still very evident. The 1958 year-class

Table 33. Age composition of haddock caught by F.R.S. "Scotia" in October 1959 per 10 hours' trawling

Area	Northern	North Central	Moray Firth
No. of hauls	6	4	2
Year-class			
1959	8	33	10
1958	800	350	205
1957	70	0	15
1956	133	20	0
1955	216	60	5
1954	40	10	0
1953 and older	5	3	0

appears to be a good one and should help to improve the fishery once it is fully recruited into the commercial landings.

0-group haddock (1959 year-class) were caught during the "Scotia" October cruise and the "Explorer" November and December cruises in rather small numbers.

Size composition

The mean lengths of haddock sampled in 1959 are given in Table 34.

British statistics

In Table 35 are given the haddock landings from the North Sea by British steam trawlers during the second half of 1958. Statistics for the first half of 1958 are given in Annales Biologiques, 15. As the British landings statistics for 1959 are not yet complete, the Scottish statistics for that year are given instead in Table 36.

R. JONES

Table 32. Age composition of haddock caught by F.R.S. "Explorer" in 1959 per 10 hour's trawling

Year-class	Area Cruise No. of hauls	Northern April 15	Moray Firth and Orkney				Central December 20
			March 5	June 5	November 4	All Cruises 14 Weighted means	
1959		0	—	—	0	0	232
1958		6,451	568	5,908	2,095	2,910	615
1957	}	853	108	92	75	93	47
1956			12	20	50	26	4
1955		1,407	40	332	395	246	66
1954	}	634	16	4	30	16	2
1953 and older			0	4	20	6	1

Table 34. Mean lengths (cm) and range of means of haddock of each age-group from the North Sea 1959

Year-class	Area		Northern			North Central			No. of fish
	Age	Cruise	Mean	Range of means	No. of fish	Cruise	Mean	Range of means	
1959	0+	Oct.	13.1	12.0-14.3	5	Oct.	13.5	11.8-15.2	10
1958	1+	April	18.6	—	9,676				
		Oct.	25.2	23.8-25.9	480	Oct.	24.8	24.6-25.1	105
1957	2+	Apr.	?	—	?				
		Oct.	33.3	31.8-35.5	42	Oct.	—	—	—
1956	3+	April	?	—	?				
		Oct.	35.2	33.2-37.0	80	Oct.	38.0	36.5-40.0	6
1955	4+	April	35.8	—	2,110				
		Oct.	37.8	35.9-42.0	130	Oct.	39.0	38.0-40.2	18
1954	5+	Oct.	42.1	39.3-45.3	24	Oct.	42.7	42.7	3

Year-class	Area		Central			Moray Firth			No. of fish
	Age	Cruise	Mean	Range of means	No. of fish	Cruise	Mean	Range of means	
1959	0+					Oct.	14.0	14.0	2
		Dec.	17.2	16.5-18.9	430				
1958	1+					Mar.	20.7	19.5-22.0	142
						June	22.0	21.5-22.5	1,477
						Oct.	27.4	26.8-28.0	41
						Nov.	28.0	26.9-29.7	419
1957	2+	Dec.	29.4	27.6-31.1	1,137				
						Mar.	29.0	22.6-35.0	27
						June	30.3	28.0-33.5	23
						Oct.	34.0	34.0	3
						Nov.	38.0	37.0-39.1	15
1956	3+	Dec.	36.2	35.1-37.2	87				
						Mar.	36.2	36.0-36.5	3
						June	37.6	34.3-41.0	5
						Oct.	—	—	—
						Nov.	39.6	39.6	10
1955	4+	Dec.	37.2	37.0-37.3	7				
						Mar.	38.4	30.5-42.0	10
						June	38.4	36.5-42.7	83
						Oct.	38.0	38.0	1
						Nov.	43.7	43.4-44.0	79
		Dec.	43.8	42.2-45.5	122				

F.R.S. "Scotia" - October; F.R.S. "Explorer" - other cruises.

Table 35. Landings of haddock by British steam trawlers from the North Sea in 1958

Quarterly period	North of Lat. 57°30'N			Lat. 55°N to 57°30'N			South of Lat. 55°00'N			All Areas		
	Weight landed/ 100 cwt.	100 hrs. fishing	Weight landed/ 100 hrs.	Weight landed/ 100 cwt.	100 hrs. fishing	Weight landed/ 100 hrs.	Weight landed/ 100 cwt.	100 hrs. fishing	Weight landed/ 100 hrs.	Weight landed/ 100 cwt.	100 hrs. fishing	Weight landed/ 100 hrs.
July-Sept.	727	406	179	452	506	89	75	550	14	1,255	1,462	86
Oct.-Dec.	1,473	758	194	344	312	110	76	697	11	1,894	1,768	107

Table 36. Landings of haddock by Scottish steam trawlers from the North Sea in 1959

Quarterly period	North of Lat. 57°30'N			Lat. 55°N to 57°30'N			All Areas		
	Weight landed/ 100 cwt.	100 hrs. fishing	Weight landed/ 100 hrs.	Weight landed/ 100 cwt.	100 hrs. fishing	Weight landed/ 100 hrs.	Weight landed/ 100 cwt.	100 hrs. fishing	Weight landed/ 100 hrs.
Jan.-March	946	517	183	103	143	72	1049	661	159
April-June	922	421	219	134	235	57	1055	656	161
July-Sept.	353	345	102	268	246	109	621	591	105
Oct.-Dec.	368	365	101	289	235	123	657	601	109

Table 37. Mean catch per 10 hours' trawling (number of fish) and age composition (%) of haddock caught by F.R.S. "Anton Dohrn" in the North Sea in June/July 1959 (Herring trawl)

Age-group	Year-class	North of 60°N	Scottish Coast (west of 1°W, north of 57°30'N)	Bressay Shoal Fladen Ground (1°W-2°E, 57°N-60°N)	Utsira, Ling Bank (east of 2°E, 57°N-60°N)
0	1959	— (—)	— (—)	13 (+)	31 (2)
I	1958	2,250 (56)	21,760 (82)	4,052 (81)	998 (57)
II	1957	327 (8)	760 (3)	141 (3)	64 (4)
III	1956	205 (5)	160 (1)	— (—)	27 (1)
IV	1955	1,023 (25)	3,620 (14)	698 (14)	445 (26)
V	1954	108 (3)	120 (+)	15 (+)	66 (4)
VI	1953	40 (1)		23 (1)	36 (2)
VII+	1952-	100 (2)		68 (1)	72 (4)
All ages		4,053 (100)	26,420 (100)	5,010 (100)	1,739 (100)
Trawl stations		8	4	12	14

Age-group	Year-class	Coastal area (west of 1°W, south of 57°30'N)	N-Dogger (south of 57°N, 1°W-4°E)	Jutland Bank (east of 4°E, north of 56°N)	German Bight (east of Dogger Bank)
0	1959	400 (10)	169 (1)	532 (44)	— (—)
I	1958	3,535 (87)	15,320 (92)	264 (22)	— (—)
II	1957	53 (1)	448 (3)	184 (15)	— (—)
III	1956	27 (+)	62 (1)	52 (4)	3 (50)
IV	1955	60 (2)	548 (3)	124 (10)	3 (50)
V	1954	— (—)	— (—)	32 (3)	— (—)
VI	1953	— (—)	— (—)	8 (+)	— (—)
VII+	1952-	— (—)	22 (+)	24 (2)	— (—)
All ages		4,075 (100)	16,569 (100)	1,220 (100)	6 (100)
Trawl stations		3	13	5	24

German Investigations

(Tables 37-39)

The density and composition of the haddock stock of the North Sea were analysed during two cruises of F.R.S. "Anton Dohrn". In June/July experimental trawling was carried out in most of the areas of the North Sea (for positions, see Fig. 37, p.158). In October only the area north of the Dogger Bank was visited. The mean catches per unit effort and the age composition are shown in Tables 37 and 38, the mean lengths of fish in each age-group in Tables 38 and 39.

The 1958 year-class proved to be abundant, being predominant in nearly all the areas visited. The strong 1955 year-class was also still present in considerable numbers, especially in the northern North Sea. Most of the haddock in age-group VII+ belonged to the 1952 year-class. On the other hand, the 1957, and especially the 1956 year-class were again very poorly represented in the catches.

0-group haddock (1959 year-class) were present already in June/July near the Jutland Bank and the British coast. They were caught in considerable numbers in October north of the Dogger Bank. Thus, the 1959 year-class seems to be fairly good.

Table 38. Mean catch per 10 hours' trawling (number of fish), age composition (%) and mean lengths (cm) of haddock caught by F.R.S. "Anton Dohrn" in the North Sea in October 1959

(Herring trawl)

Age-group	Year-class	Area north of the Dogger Bank (55°-57° N, west of 6° E)				
		No. of fish	%	Mean length	Range	No. of fish
0	1959	2,317	(37)	17.5	10-22	258
I	1958	3,885	(61)	28.3	22-34	335
II	1957	91	(1)	36.6	32-42	22
III	1956	11	(+)	(34.0)	32-38	3
IV	1955	44	(1)	43.0	33-51	22
V+	1954-	3	(+)	(54.0)	47-57	5
All ages		6,351	(100)			
Trawl stations		32				

In general, the density of the haddock stock in the North Sea has increased. After the two poor year-classes (1956 and 1957) a numerous recruitment appeared in 1958, followed probably by a fairly good year-class in 1959.

D. SAHRHAGE

Table 39. Mean lengths (cm) of haddock caught by F.R.S. "Anton Dohrn" in the North Sea in June/July 1959
(Herring trawl)

Age-group	Year-class	North of 60°N			Scottish Coast			Bressay Shoal/ Fladen Ground			Utsira/Ling Bank		
		Mean	Range	No. of fish	Mean	Range	No. of fish	Mean	Range	No. of fish	Mean	Range	No. of fish
0	1959	—	—	—	—	—	—	(8.3)	5-10	8	9.2	6-12	22
I	1958	23.6	18-26	89	22.4	17-29	145	22.8	16-29	113	23.0	17-28	237
II	1957	32.7	26-37	29	(30.4)	26-33	8	31.8	28-35	23	32.5	27-36	23
III	1956	(38.5)	29-43	21	(33.5)	32-34	2	—	—	—	35.4	33-39	12
IV	1955	36.6	31-44	115	34.0	30-43	34	36.1	29-41	124	40.2	33-49	208
V	1954	42.0	32-50	16	—	—	—	(37.8)	36-38	3	45.0	37-51	32
VI	1953	(42.2)	34-47	6	—	—	—	(38.8)	34-41	4	46.6	40-57	20
VII+	1952-	43.9	37-51	16	—	—	—	(39.7)	35-44	10	52.7	43-63	38

Age-group	Year-class	Coastal Area			N-Dogger			Jutland Bank			German Bight		
		Mean	Range	No. of fish	Mean	Range	No. of fish	Mean	Range	No. of fish	Mean	Range	No. of fish
0	1959	9.8	8-10	15	10.0	7-12	110	11.7	8-13	133	only a small number of fish caught		
I	1958	24.0	16-28	78	25.2	18-29	251	26.6	21-30	66			
II	1957	(29.5)	28-32	8	33.5	24-37	31	34.0	26-39	46			
III	1956	(34.3)	32-35	4	(37.1)	35-40	8	38.5	34-43	13			
IV	1955	(40.6)	35-42	9	39.2	32-48	70	44.3	37-56	31			
V	1954	—	—	—	—	—	—	(50.9)	42-57	8			
VI	1953	—	—	—	—	—	—	(52.0)	41-62	2			
VII+	1952-	—	—	—	(46.2)	43-51	3	(58.7)	50-67	6			

WHITING*)

North Sea Stock

Scottish Investigations

(Tables 40—44)

Age composition

The age compositions of whiting captured by F.R.S. "Explorer" and F.R.S. "Scotia" in the North Sea during 1959 are shown in Tables 40 and 41. The 1955 year-class was again well represented in the catches, while there were indications from all areas that the 1958 year-class was somewhat larger than the two preceding year-classes. The greatest number of fish in the six years and older grouping belonged to the very good 1952 year-class.

Table 41. Age composition of whiting caught by F.R.S. "Scotia" in October 1959 per 10 hours' trawling

Area	Northern	North Central	Moray Firth
No. of hauls	6	4	2
Year-class			
1959	2	22	None otolithed
1958	13	320	
1957	82	332	
1956	15	50	
1955	70	275	
1954	7	15	
1953 and older	20	42	

Table 40. Age composition of whiting caught by F.R.S. "Explorer" in 1959 per 10 hours' trawling

Year-class	Area Cruise No. of hauls	Northern April 15	March 5	Moray Firth and Orkney		All Cruises 14 Weighted means	Central December 20
				June 5	November 4		
1959		—		—	900	900	1,598
1958		13	508	1,444	755	913	3,753
1957		764	1,276	2,296	185	1,329	878
1956		226	136	360	5	179	2
1955		1,075	556	380	80	357	290
1954		192	76	28	5	39	2
1953 and older		368	404	124	45	201	12

*) See also p. 100.

Table 42. Mean lengths (cm) and range of means of whiting of each age-group from the North Sea in 1959

Area			Northern			North Central			No. of fish
Year-class	Age	Cruise	Mean	Range of means	No. of fish	Cruise	Mean	Range of means	
1959	0+	April	—	—	—				
		Oct.	12.0	12.0	1	Oct.	14.0	14.0	9
1958	1+	April	19.8	19.8	36				
		Oct.	26.2	26.2	8	Oct.	24.4	24.0-24.8	128
1957	2+	April	26.5	26.5	2,140				
		Oct.	30.0	28.0-33.0	51	Oct.	29.7	28.2-31.7	133
1956	3+	April	31.4	30.8-32.0	632				
		Oct.	32.4	31.8-33.0	9	Oct.	30.0	28.8-31.4	20
1955	4+	April	33.4	31.7-35.0	3,009				
		Oct.	33.6	32.0-36.3	52	Oct.	32.4	30.1-34.3	110
1954	5+	April	32.1	32.1	539				
		Oct.	35.0	35.0	5	Oct.	33.0	32.7-33.0	6
1953	6+	April	34.7	34.7	165				
		Oct.	—	—	—	Oct.	32.8	32.7-33.0	5
1952	7+	April	40.0	33.9-46.0	823				
		Oct.	37.2	34.3-39.0	14	Oct.	—	—	—
Area			Central			Moray Firth and Orkney			No. of fish
Year-class	Age	Cruise	Mean	Range of means	No. of fish	Cruise	Mean	Range of means	
1959	0+					March	—	—	—
						June	—	—	—
						Nov.	15.0	14.7-15.3	180
1958	1+	Dec.	15.6	15.2-16.1	4,204	March	18.2	15.0-23.0	127
						June	21.2	20.2-22.5	361
						Nov.	26.4	25.3-27.5	151
1957	2+	Dec.	25.4	25.3-25.6	3,939	March	25.9	22.0-28.5	319
						June	26.8	25.9-27.6	574
						Nov.	32.4	30.3-35.2	37
1956	3+	Dec.	29.9	28.5-31.3	1,261	March	32.2	28.9-36.5	34
						June	28.2	26.0-30.0	9
						Nov.	38.0	38.0	1
1955	4+	Dec.	38.7	38.7	7	March	34.0	31.3-37.0	139
						June	32.9	30.4-36.0	95
						Nov.	35.4	29.0-39.0	16
1954	5+	Dec.	34.6	32.4-36.8	326	March	36.9	31.8-43.0	19
						June	35.9	31.5-38.7	7
						Nov.	41.0	41.0	1
1953	6+	Dec.	40.1	40.1	7	March	38.0	32.0-42.0	6
						June	40.6	39.0-42.2	5
						Nov.	—	—	—
1952	7+	Dec.	40.0	40.0	2	March	38.3	37.0-40.5	81
						June	35.6	33.5-37.6	22
						Nov.	39.4	38.8-40.0	6
		Dec.	42.2	42.2	25				

F.R.S. "Scotia" - October (no figures for the Moray Firth area); F.R.S. "Explorer" - other cruises.

Table 43. Landings of whiting by British steam trawlers from the North Sea in 1958

Quarterly period	North of Lat. 57°30'N			Lat. 55°N to 57°30'N			South of Lat. 55°00'N			All Areas		
	Weight landed/100 cwt.	100 hrs. fishing	Weight landed/100 hrs.	Weight landed/100 cwt.	100 hrs. fishing	Weight landed/100 hrs.	Weight landed/100 cwt.	100 hrs. fishing	Weight landed/100 hrs.	Weight landed/100 cwt.	100 hrs. fishing	Weight landed/100 hrs.
July-Sept.	210	406	52	151	506	30	29	550	5	390	1,462	27
Oct.-Dec.	619	758	82	104	312	33	28	697	4	751	1,768	42

Table 44. Landings of whiting by Scottish steam trawlers from the North Sea in 1959

Quarterly period	North of Lat. 57°30'N			Lat. 55°N to 57°30'N			All Areas		
	Weight landed/ 100 cwt.	100 hrs. fishing	Weight landed/ 100 hrs.	Weight landed/ 100 cwt.	100 hrs. fishing	Weight landed/ 100 hrs.	Weight landed/ 100 cwt.	100 hrs. fishing	Weight landed/ 100 hrs.
Jan.-March	407	517	79	62	143	43	469	661	71
April-June	201	421	48	33	235	14	234	656	36
July-Sept.	197	345	57	74	246	30	271	591	46
Oct.-Dec.	339	365	93	72	235	30	411	601	68

Size composition

The mean lengths of whiting sampled in the North Sea during 1959 are given in Table 42. All the figures are from "Explorer" hauls except the October samples in the Northern and North Central areas, which are from "Scotia" data. The routine trawling surveys of the North Sea previously carried out by the "Explorer" have now been taken over by the "Scotia", and the latter's October cruise is the first of this new series.

British statistics

A summary of the whiting landings by British steam trawlers from the North Sea for the last six months of 1958 is given in Table 43. In the absence of complete statistics for 1959, the landings by Scottish trawlers during that year are given instead in Table 44.

R. GAMBLE

German Investigations

(Figures 37-38; Tables 45-50)

Sampling of whiting was carried out during three cruises of F.R.S. "Anton Dohrn". In January experimental hauls were made with the herring trawl in the southern North Sea and the eastern part of the English Channel. During the second

cruise in June/July nearly all areas of the North Sea were visited (see Fig. 37). Further investigations in October were restricted to the Shields area, Dogger Bank, and German Bight (see Figure 27, p. 121, Ann. Biol., 15). The mean catches of whiting per 30 min. trawling and the age compositions are given in Tables 45-47, the corresponding mean lengths of whiting in each age-group are shown in Tables 48-50.

Whiting of the 1958 year-class were predominant in most of the areas. Also the 1957 year-class was well represented, especially in the southern North Sea, the German Bight, and near the Scottish coast. In the northern and north-western North Sea as well as in the English Channel a considerable proportion of the catches consisted of whiting belonging to the good 1955 year-class and, to a lower extent, to the 1956 brood. Generally the density of whiting in the North Sea proved to be higher than in the two preceding years.

0-group whiting (1959 year-class) were encountered first in June/July in the Jutland Bank area. Then in October these small fishes were caught in quite considerable numbers off the English coast, north of the Dogger Bank, and in the German Bight. These catches of 0-group whiting per 30 min. trawling are shown in Figure 38. The 1959 brood seems to be fairly good.

The special investigations on the wide-spaced distribution of whiting carried out in June/July

Table 45. Mean catch per 30 min. trawling (number of fish) and age composition (%) of whiting caught by F.R.S. "Anton Dohrn" in the southern North Sea and English Channel in January 1959
(Herring trawl)

Age-group	Year-class	Clay Deep		S-Dogger		Southern Bight (51°N-53°N)		English Channel (eastern area)	
0	1958	212	(23)	18	(3)	—	(—)	—	(—)
I	1957	484	(54)	50	(9)	209	(19)	8	(11)
II	1956	117	(13)	228	(41)	264	(23)	10	(14)
III	1955	87	(10)	246	(44)	487	(43)	41	(58)
IV	1954	—	(—)	15	(3)	160	(14)	11	(16)
V	1953	—	(—)	—	(—)	15	(1)	1	(1)
VI	1952	—	(—)	2	(+)	—	(—)	—	(—)
All ages		900	(100)	559	(100)	1,135	(100)	71	(100)
Trawl stations		1		1		2		6	



Figure 37. Distribution of whiting in the North Sea in June/July 1959 according to the results of experimental trawling with F.R.S. "Anton Dohrn". (Catches of whiting per 30 min. trawling with herring trawl. Isolines for 1000 and 200 fish per 30 min. are shown. Catches in the German Bight made by smaller cutter trawl with small-meshed cover, converted to catches of herring trawl by raising factor 5.4.)

Table 46. Mean catch per 30 min. trawling (number of fish) and age composition (%) of whiting caught by F.R.S. "Anton Dohrn" in the North Sea in June/July 1959
(Herring trawl)

Age-group	Year-class	North of 60°N		Scottish Coast (north of 57°N, west of 0°)		Shields Area		Utsira/Ling Bank (north of 57°N, east of 0°)		Jutland Bank	
0	1959	—	(—)	—	(—)	—	(—)	—	(—)	19	(40)
I	1958	+	(1)	78	(13)	1,145	(50)	67	(39)	19	(40)
II	1957	3	(10)	179	(30)	587	(26)	46	(27)	6	(13)
III	1956	7	(21)	115	(19)	490	(21)	35	(20)	1	(2)
IV	1955	17	(52)	134	(23)	66	(3)	20	(12)	2	(4)
V	1954	4	(12)	60	(10)	18	(+)	4	(2)	+	(1)
VI	1953	1	(1)	10	(2)	—	(—)	+	(+)	—	(—)
VII+	1952-	1	(3)	20	(3)	—	(—)	+	(+)	—	(—)
All ages		33	(100)	596	(100)	2,306	(100)	172	(100)	47	(100)
Trawl stations	..	8		11		1		21		5	

Age-group	Year-class	N-Dogger		W-Dogger		S-Dogger		German Bight ¹⁾		Danish and German Coast ¹⁾		Southern Bight (south of 54°N)	
0	1959	+	(+)	—	(—)	—	(—)	6	(+)	1	(1)	—	(—)
I	1958	209	(55)	748	(77)	50	(16)	310	(22)	73	(63)	126	(34)
II	1957	70	(19)	125	(13)	115	(36)	738	(53)	40	(35)	164	(44)
III	1956	65	(17)	75	(8)	82	(26)	162	(12)	1	(1)	49	(13)
IV	1955	30	(8)	23	(2)	50	(16)	175	(13)	+	(+)	27	(7)
V	1954	4	(1)	1	(+)	14	(4)	4	(+)	—	(—)	4	(1)
VI	1953	+	(+)	—	(—)	6	(2)	1	(+)	—	(—)	1	(1)
VII+	1952-	1	(+)	—	(—)	1	(+)	1	(+)	—	(—)	—	(—)
All ages		379	(100)	972	(100)	318	(100)	13,97	(100)	115	(100)	371	(100)
Trawl stations	..	13		1		1		21		7		4	

¹⁾ Converted from experimental catches made by cutter trawl with small-meshed cover, raising factor 5.4.

Table 47. Mean catch per 30 min. trawling (number of fish) and age composition (%) of whiting caught by F.R.S. "Anton Dohrn" in the North Sea in October 1959
(Herring trawl)

Age-group	Year-class	Shields Area		Dogger Bank		S-Dogger		W-Dogger		German Bight ¹⁾		53°25'N, 2°51'E	
0	1959	3,080	(58)	1,182	(71)	204	(17)	161	(19)	2,009	(97)	128	(20)
I	1958	1,749	(33)	346	(21)	781	(66)	416	(49)	49	(3)	461	(72)
II	1957	384	(7)	109	(6)	156	(13)	240	(28)	5	(+)	35	(6)
III	1956	100	(2)	29	(2)	34	(3)	23	(3)	1	(+)	14	(2)
IV	1955	—	(—)	7	(+)	4	(1)	7	(1)	—	(—)	—	(—)
V	1954	—	(—)	1	(+)	—	(—)	—	(—)	—	(—)	—	(—)
VI	1953	—	(—)	—	(—)	—	(—)	+	(+)	—	(—)	—	(—)
VII+	1952-	—	(—)	+	(+)	—	(—)	—	(—)	—	(—)	—	(—)
All ages		5,313	(100)	1,674	(100)	1,179	(100)	847	(100)	2,064	(100)	638	(100)
Trawl stations	..	1		41		4		7		1		1	

¹⁾ Converted from experimental catch with cutter trawl by raising factor 5.4

Table 48. Mean lengths (cm) of whiting caught by F.R.S. "Anton Dohrn" in the southern North Sea and English Channel in January 1959
(Herring trawl)

Age-group	Year-class	Clay Deep			S-Dogger			Southern Bight (51°N-53°N)			English Channel (eastern area)		
		Mean	Range	No. of fish	Mean	Range	No. of fish	Mean	Range	No. of fish	Mean	Range	No. of fish
0	1958	15.4	11-18	40	13.6	11-15	9	—	—	—	—	—	—
I	1957	19.8	14-23	82	20.8	16-24	20	20.9	17-25	69	22.4	17-26	50
II	1956	24.8	21-29	32	25.7	21-30	62	25.0	21-30	57	26.2	23-29	56
III	1955	26.3	23-30	31	28.8	22-35	72	28.5	23-33	98	28.9	23-35	238
IV	1954	—	—	—	(36.5)	33-41	7	33.6	29-38	30	33.8	28-42	65
V	1953	—	—	—	—	—	—	(38.0)	37-38	2	(41.5)	40-44	4
VI	1952	—	—	—	(33.5)	33	1	—	—	—	—	—	—

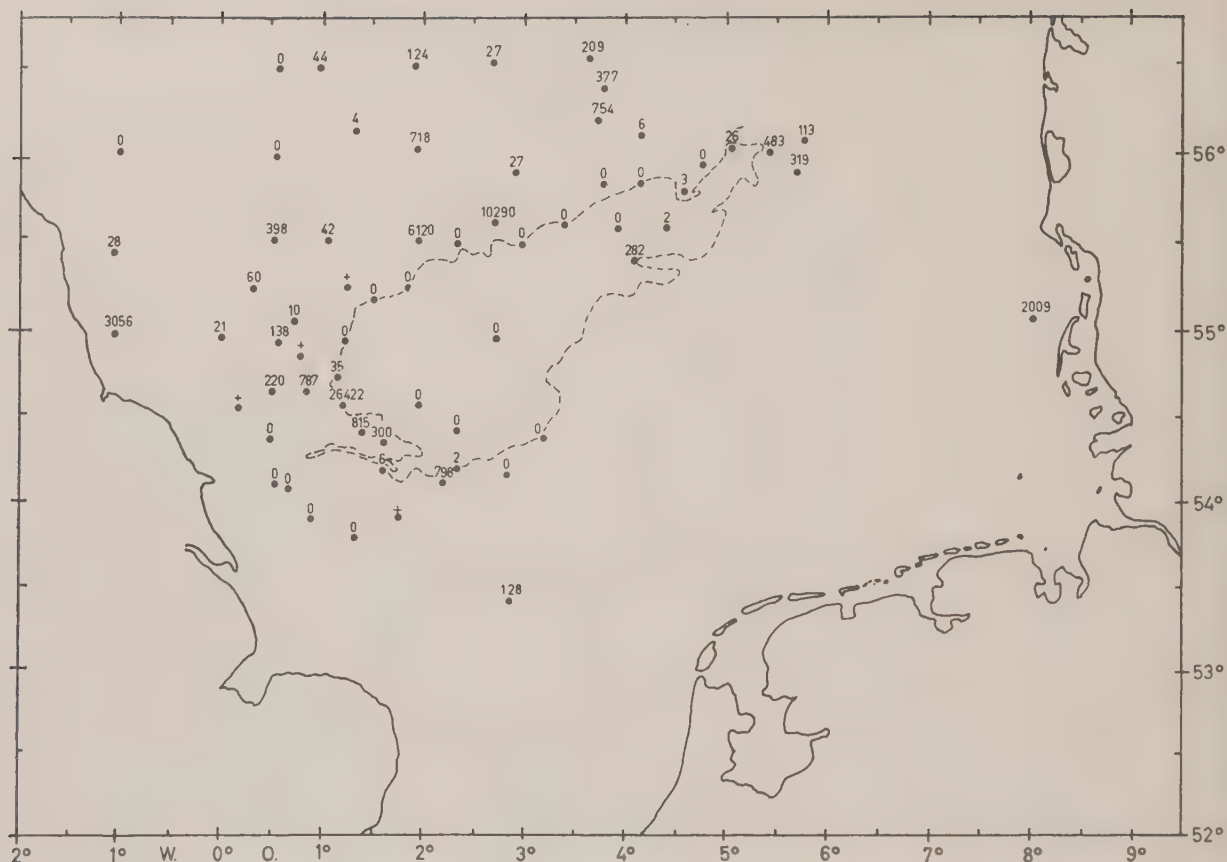


Figure 38. Catches of 0-group whiting (1959 year-class) per 30 min. trawling with F.R.S. "Anton Dohrn" in October 1959 (herring trawl).

Table 50. Mean lengths (cm) of whiting caught by F.R.S. "Anton Dohrn" in the North Sea in October 1959 (Herring trawl)

Age-group	Year-class	Shields Area			Dogger Bank			S-Dogger		
		Mean	Range	No. of fish	Mean	Range	No. of fish	Mean	Range	No. of fish
0	1959	14.4	10—19	22	14.0	8—20	187	(14.4)	11—17	7
I	1958	22.4	18—26	24	22.4	18—29	444	22.5	17—27	77
II	1957	(27.5)	24—33	7	26.1	21—33	213	26.0	23—29	24
III	1956	(32.5)	30—35	3	29.6	25—39	86	(29.4)	26—34	7
IV	1955	—	—	—	32.1	28—46	44	(33.7)	32—36	6
V	1954	—	—	—	42.6	36—47	13	—	—	—
VI	1953	—	—	—	—	—	—	—	—	—
VII+	1952—	—	—	—	(43.5)	37—53	3	—	—	—
Age-group	Year-class	W-Dogger			German Bight ¹⁾			53°25'N, 2°51'E		
		Mean	Range	No. of fish	Mean	Range	No. of fish	Mean	Range	No. of fish
0	1959	(15.0)	12—17	6	15.4	8—20	89	14.8	11—17	13
I	1958	21.3	17—24	23	21.6	18—26	10	22.8	19—29	65
II	1957	23.9	21—29	14	(26.4)	23—31	3	(24.7)	23—29	7
III	1956	30.5	27—36	28	(27.5)	27	1	(25.2)	23—26	2
IV	1955	33.9	31—38	10	—	—	—	—	—	—
V	1954	—	—	—	—	—	—	—	—	—
VI	1953	(51.5)	51	1	—	—	—	—	—	—
VII+	1952—	—	—	—	—	—	—	—	—	—

¹⁾ Caught by cutter trawl with small-meshed cover.

Table 49. Mean lengths (cm) of whiting caught by F.R.S. "Anton Dohrn" in the North Sea in June/July 1959

Age-group	Year-class	North of 60°N			(Herring trawl) Scottish Coast			Shields Area			Utsira/Ling Bank		
		Mean	Range	No. of fish	Mean	Range	No. of fish	Mean	Range	No. of fish	Mean	Range	No. of fish
0	1959	—	—	—	—	—	—	—	—	—	—	—	—
I	1958	(20.5)	17—23	2	22.3	12—28	123	20.5	15—25	24	22.6	16—25	66
II	1957	28.2	24—31	26	26.9	22—31	122	23.8	21—30	38	26.0	22—30	50
III	1956	30.0	25—34	51	27.8	23—33	79	25.9	22—33	72	29.4	25—38	81
IV	1955	33.4	28—40	125	31.0	27—37	123	30.6	27—33	33	32.6	27—39	91
V	1954	36.6	31—45	29	31.5	27—37	59	(35.3)	29—38	9	34.9	29—41	22
VI	1953	(38.2)	35—42	3	36.4	32—45	17	—	—	—	(36.2)	34—42	3
VII+	1952—	(38.2)	33—44	7	(35.9)	29—45	35	—	—	—	(32.5)	32	1

Age-group	Year-class	Jutland Bank			N-Dogger			W-Dogger			S-Dogger		
		Mean	Range	No. of fish	Mean	Range	No. of fish	Mean	Range	No. of fish	Mean	Range	No. of fish
0	1959	10.7	7—13	93	9.6	8—10	11	—	—	—	—	—	—
I	1958	18.4	15—21	97	20.7	16—25	66	18.2	14—23	119	18.4	13—21	36
II	1957	22.2	20—25	31	24.3	21—30	103	22.1	19—26	39	20.9	18—26	70
III	1956	(27.5)	26—28	4	27.0	21—33	160	27.4	23—34	30	27.8	22—35	72
IV	1955	(32.5)	28—37	9	31.8	26—38	105	(28.8)	24—35	8	30.7	23—41	43
V	1954	(27.5)	27	1	34.2	29—37	16	(36.5)	36	1	34.9	28—47	14
VI	1953	—	—	—	(35.5)	35	1	—	—	—	(35.0)	32—37	5
VII+	1952—	—	—	—	(35.3)	33—38	9	—	—	—	(39.5)	39	1

Age-group	Year-class	German Bight ¹⁾			Danish and German Coast ¹⁾			Southern Bight		
		Mean	Range	No. of fish	Mean	Range	No. of fish	Mean	Range	No. of fish
0	1959	6.8	5—8	6	10.2	8—10	6	—	—	—
I	1958	17.7	12—21	84	16.9	13—22	511	19.7	13—22	60
II	1957	20.2	15—25	230	19.2	16—25	282	22.4	17—30	68
III	1956	24.4	19—31	86	(24.1)	21—25	5	26.2	22—33	51
IV	1955	27.6	24—36	139	(25.5)	25	1	26.5	23—35	26
V	1954	(31.0)	27—34	6	—	—	—	(29.8)	26—35	4
VI	1953	(27.5)	27	1	—	—	—	(32.8)	31—35	2
VII+	1952—	(35.5)	35	1	—	—	—	—	—	—

¹⁾ Caught by cutter trawl with small-meshed cover.

showed two areas of whiting concentrations in the North Sea, one of which is in the north-western North Sea, the other in the south-eastern North Sea (Fig. 37). Both areas are separated by a zone of low density which extends to the northern and north-eastern North Sea. The whiting in the two areas of high density are different as to their

growth-rate (Table 49) and number of vertebrae. The mean number of vertebrae for the whiting in the north-western area was calculated as 53.74 ± 0.067 (urostyl not counted), whereas the average for the whiting in the German Bight was 53.54 ± 0.066 .

D. SAHRHAGE

Herring

INTRODUCTION

Twenty contributions, on the results of work carried out by ten countries on Herring in the I.C.E.S. area in 1959 are contained in this report, as follows:—

Belgium:	Poland:
CH. GILIS	J. ELWERTOWSKI
Denmark:	H. JANKO
AA. J. C. JENSEN	J. POPIEL
	K. STRZYZEWSKA
Germany:	Scotland:
K. SCHUBERT	B. B. PARRISH
P. F. MEYER-WAARDEN	I. G. BAXTER
K. TIEWS	G. MCPHERSON
Iceland:	J. D. BUCHAN
ARNI FRIDRIKSSON	A. SAVILLE
Netherlands:	Sweden:
K. H. POSTUMA	H. HÖGLUND
J. ZIJLSTRA	U.S.S.R.:
Norway:	I. YUDANOV
FINN DEVOLD	L. N. LISIVNENKO
O. DRAGESUND	
O. ØSTVEDT	

These contributions provide a comprehensive survey of the size and composition of the catches taken in most of the major juvenile and adult herring fisheries in the Distant Northern Seas, Near Northern Seas, and Baltic-Belts sub-areas respectively. Other relevant data are also published in I.C.E.S. Statistical News Letters and Stock Records.

The most important feature of the herring fisheries in the Distant Northern Seas was the continued low yield from the Norwegian west coast fishery. Although landings in 1959 were higher than in 1958, they remained at a very low level compared with earlier years. Further, the changed pattern of the fishery persisted in 1959. As in 1958, the main body of adult fish spawned on northerly grounds and arrived there later. This, together with further poor recruitment, led to poor fishing on the customary grounds to the south. The Norwegian investigations indicate that, as a result of

continued poor recruitment, a further reduction in the size of the adult spawning stock must be expected in the next few years. This is also indicated by Soviet data for the Barents Sea.

In contrast, the Iceland north coast fishery improved in 1959, yielding over twice the quantity of herring as in 1958. This was due, in the main, to an increase in the supply of the Icelandic spring spawning tribe. The contribution made by the Norwegian tribes was, on the whole, small.

The striking features of the herring fisheries in the North Sea were as follows: —

- (1) Increases in landings and catch/effort from the summer and autumn drift-net and trawl fisheries on "Bank" herring in the northern and central regions of the North Sea.
- (2) The continued failure of the Southern Bight (East Anglian) drift-net fishery.
- (3) Increased landings from the Southern Bight and eastern English Channel trawl fishery.
- (4) The entry of the very abundant 1956 year-class on to the northern and central North Sea fishing grounds. This was mainly responsible for the relatively successful fisheries in these regions. This year-class also contributed largely to the increased yields from the Southern Bight trawl fisheries, but did not appear in abundance in the Southern Bight drift-net fishery. Attention is drawn in the German contribution to the occurrence of "unusual" meristic characters amongst members of this year-class in the northern North Sea.
- (5) The continued scarcity of the older age-groups, especially on the Southern Bight grounds. Particular attention is drawn to this, and the need for international conservation action, in the Belgian contribution.

Surveys of the Danish and Polish herring investigations are provided for the Baltic-Belts area. The results of Soviet investigations of the effect of environmental factors on larval survival, and Polish investigations on fecundity of spring and autumn spawners are also given.

B. B. PARRISH

A. Distant Northern Seas

COMMERCIAL FISH

The Icelandic North Coast Herring in 1959

(Figures 1-3; Tables 1-8)

A. The Fishery

Landings were considerably better than in any other season since 1944, as it appears from the following figures, where the years 1944, 1958, and 1959 are compared.

Year	1944	1958	1959
No. of vessels	141	241	224
Total catch, hecto- litres	2,390,384	704,012	1,597,694
Av. catch per vessel .	16,951	3,226	7,133

It is noted that the catches were much smaller in 1959 than in 1944 in spite of better equipment and much better techniques to discover the shoals. As the herring did not appear very much at the surface, the yields would certainly have been poor if the vessels had not been equipped with echosounders and asdics. The figures for 1958 and 1959 can therefore not be compared with those from 1944 without having this in mind. The figures for 1958 and 1959 are, however, comparable.

B. Biological features of the stock

The material for 1959 comprised 47 samples, containing 4,141 fish. Samples Nos. 9, 11, 39, and 40 were taken from outside the stocks upon which the fishery was based. No. 9 came from land-seine and consisted mainly of small herring, No. 11 came from the SW coast and Nos. 39 and 40 were taken in gill-nets in Reydarfjord on the E coast. None of these samples are included in the tables. All localities from which the samples originated are shown in Figure 1. The whole season could be divided into periods characterized by different composition of the landings and different density of the herring shoals. The distribution of the samples which indicates the principal localities of fishing, shows that although much fishing took place far off shore, quite a number of landings came from coastal waters, a fact which has not been experienced for many years.

The figures in Table 1 show the size distribution and the average length for fish in 1959. The relatively few landings of drift-net herring are included, as there was no difference in size when compared with the seine-caught fish. However, the length of the herring varied considerably from time to time and from place to place, as can be seen from the table,

where the columns (A, B, C, and D) correspond to the sections in Figure 1. At the beginning of the season, when the fishing took place off the western part of the coast the mean length was very high (35.83 cm). During the first half of July, immigration of smaller fish seems to have taken place; the catches increased considerably and the fishing fleet moved further east. Later on, relatively small fish (C), partly consisting of summer spawners, moved into the area from the west, and off the east coast (D) the catches were mixed with some immature fish. The average lengths of all north coast herring (35.07 cm) was considerably lower than in 1958 (35.69 cm).

The composition of the catches as to tribes is shown in Table 2 and Figure 2. Taken as a whole, the contribution of the Norwegian tribes was small, being 187‰ as compared with 215‰ in 1957 and 198‰ in 1956. But there is a great difference between the sections. There were relatively many Norwegian herring on the western grounds (B) early in the season and east of Iceland (D), at the end of the season, and it must be remembered that the bulk of the landings came from B and C. Section A was characterized by the relatively high number of Icelandic spring spawners, and in section C the invasion of summer spawners from the south is evident. It should be mentioned that distinction between the Icelandic spring spawners and the southern Norwegian tribe by means of the scale pattern has proved to be extremely difficult during recent years. Therefore, the possibility exists that a number of herring of the southern Norwegian type is erroneously identified as Icelandic spring spawners.

The age compositions of the tribes in 1959 are shown in Table 3 and Figure 3. There were 19 year-classes in the landings, aged from 3 to 21 years. If we compare the figures in the table with those of the corresponding table in Ann. Biol., 15 : 127 it appears that the same year-classes were generally predominating. Actually, there has been no marked alteration in composition during three or four years. The increased yields in 1959 were therefore not due to the appearance of a new year-class but merely to more favourable migrations.

In the NN tribe we find the average age of 11.6 years, or nearly the same as in 1958 (11.9). The relative strengths of the dominant year-classes were 110‰ (1951 year-class), 299‰ (1950), and 125‰

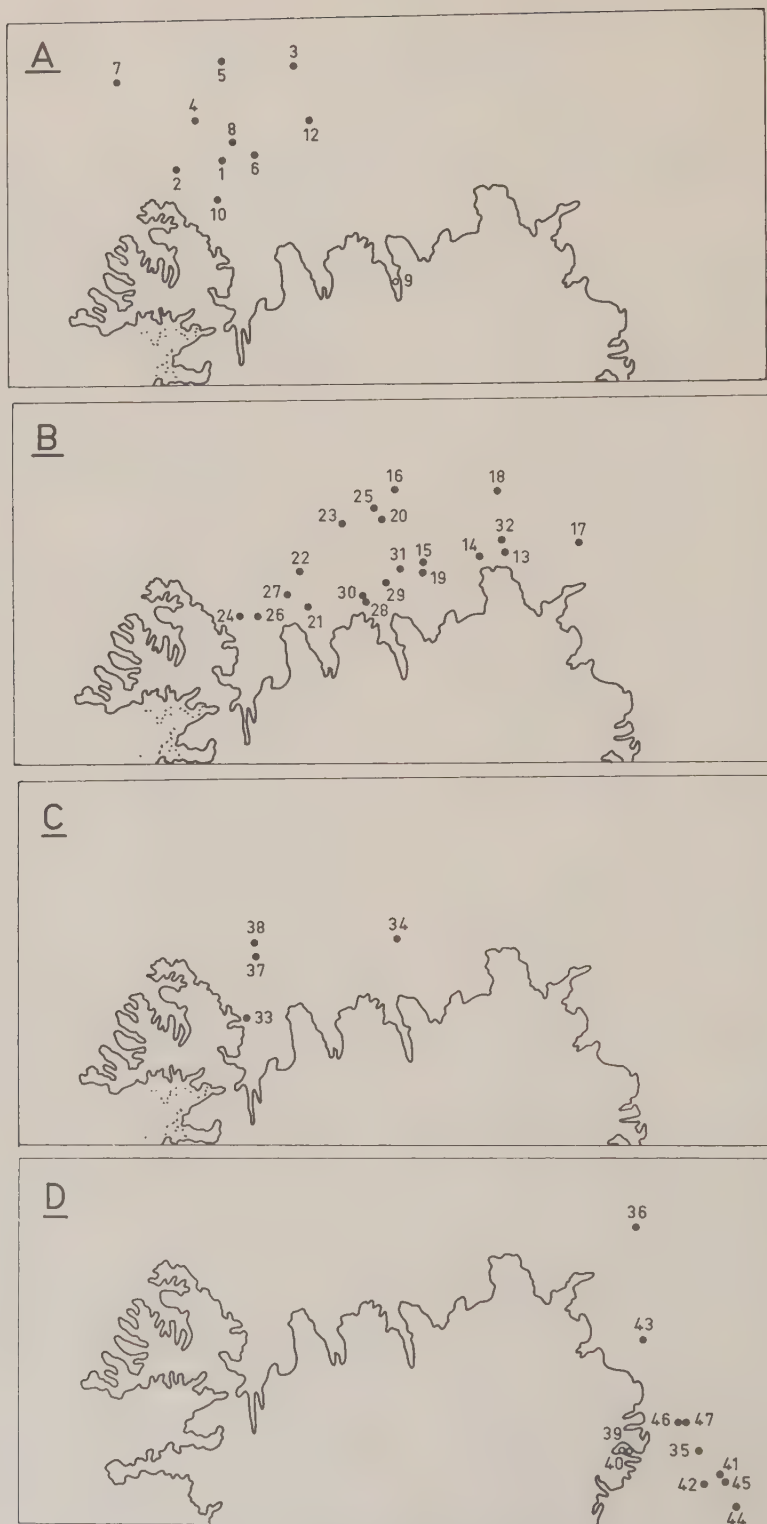


Figure 1. Localities of sampling in 1959 (see Tables 1 and 2).

Table 1. Length distribution of north coast herring (‰)

	A	B	C	D	Total
Sample nos.	1-8		34	35-36	
	10, 12	13-32	37-38	41-47	
Dates	19. VI- 8. VII	9.-31. VII	8.-14. VII + 3. VIII	8. VII- 15. VIII	
cm					
41	—	1	—	—	+
40	—	2	—	—	1
39	6	19	—	3	14
38	86	120	25	22	98
37	250	195	58	80	192
36	297	200	121	162	212
35	200	190	265	140	204
34	100	123	248	235	127
33	41	49	91	82	52
32	16	27	86	52	30
31	2	28	50	27	22
30	2	23	41	14	26
29	—	14	15	85	15
28	—	7	—	60	6
27	—	1	—	30	1
26	—	—	—	8	+
25	—	1	—	—	+
Total	1000	1000	1000	1000	1000
Number of fish	999	1982	396	365	3741
Mean	35.83	35.36	34.12	34.42	35.07

Table 3. Age of north coast herring in 1959

Age	Year	NN	NS	ISPR	ISUM	?)	Total
3	1956	—	—	28	61	—	26
4	1955	—	—	33	100	—	35
5	1954	—	—	39	100	—	39
6	1953	4	19	77	158	—	72
7	1952	26	38	85	179	137	86
8	1951	110	160	137	172	91	139
9	1950	299	265	272	111	45	255
10	1949	54	75	135	63	45	113
11	1948	84	66	29	23	45	38
12	1947	125	199	30	11	182	48
13	1946	58	94	45	13	137	46
14	1945	48	19	68	9	—	56
15	1944	56	47	10	—	91	17
16	1943	34	9	5	—	137	10
17	1942	18	9	4	—	—	6
18	1941	22	—	2	—	45	5
19	1940	24	—	1	—	45	4
20	1939	26	—	—	—	—	3
21	1938	12	—	—	—	—	2
Total		1000	1000	1000	1000	1000	1000
Number		499	106	2334	379	22	3340
?)		16	—	—	—	386	402
Grand Total		515	106	2334	379	408	3742
‰		155	32	700	113	—	1000
Average age		11.6	10.4	9.0	6.9	12.4	9.1

1) Scales not fit for determination of type.

2) Scales not fit for age reading.

NN = North Norway type
 NS = South Norway type
 ISPR = Icelandic spring spawners
 ISUM = Icelandic summer spawners

Table 2. Relative strength of the tribes (‰)

Sections	A	B	C	D	Total
NN	60	214	31	185	155
NS	4	43	0	87	32
ISPR	926	698	212	564	700
ISUM	10	45	757	164	113
Total	1000	1000	1000	1000	1000
Number	943	1756	321	298	3318

(1947). They are generally stronger than in 1958, where we found the corresponding figures for 1951 and 1950 to be 95‰ and 175‰ respectively, with the exception of the 1947 year-class which was stronger in 1958 (146‰).

In the NS tribe the same year-classes were predominant as in 1958. The main difference is that the 1950 year-class was much stronger (265‰) than in the previous year (158‰) and the 1947 year-class (199‰) much weaker. The average age (10.4) was about the same as in 1958 (10.3).

The composition of the Icelandic spring spawners was very similar to that of 1958 except for the fact that the 1945 year-class (130‰) was much less pronounced in 1959 (68‰). The average age (9.0 years) was therefore slightly lower than in 1958 (9.2).

There were more young herring in the summer spawning tribe than in 1958 and the average age (6.9) was, consequently, somewhat lower than in the previous year (7.2). The 1951, 1952, and 1953 year-classes were predominant, as in 1958.

Owing to the great influence of Icelandic herring, the average age of the total stock (9.1 years) was even lower than it was in 1958 (9.3). The three best year-classes were those from 1949 (113‰), 1950 (255‰), and 1951 (139‰). They contributed slightly more than the other 16 year-classes.

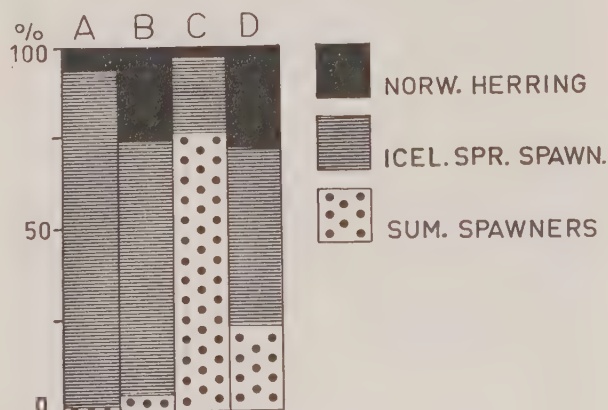


Figure 2. The compositions of the landings by sections (see Fig. 1).

Table 4. Total number of vertebrae by tribes (V.S.)

V.S.	NN	NS	ISPR	ISUM	?	Total
60	—	—	3	—	—	+
59	10	19	13	3	5	12
58	272	330	283	167	245	267
57	611	529	580	635	606	592
56	101	113	113	184	135	121
55	4	9	8	8	7	7
54	2	—	—	3	2	1
Total ..	1000	1000	1000	1000	1000	1000
Number	515	106	2334	379	408	3742
Mean ..	57.17	57.24	57.18	56.96	57.24	57.15
± m ...	0.03	0.07	0.01	0.03	0.04	0.01

Table 5. Vertebral differences between the tribes

Tribe	Number	A		B		
		V.S.	± m	ISUM	ISPR	NS
NN ...	515	57.17	0.03	5.0	0.3	0.9
NS ...	106	57.24	0.07	4.0	0.9	—
ISPR ...	2334	57.18	0.01	7.3	—	—
ISUM ...	379	56.96	0.03	—	—	—

Table 6. Total number of vertebrae by maturity

Maturity	Number	V.S.	± m
II	111	57.11	0.06
III	1067	57.19	0.06
IV	58	57.31	0.12
V	22	57.05	0.10
VII	20	57.20	0.12
VIII	2464	57.14	0.06

In Table 4 a survey is given of the distribution of vertebrae etc. within the various tribes. In the NN tribe the vertebral count was higher (57.17) than in 1958 (57.14), but approximately the same as in 1957 (57.18), and the same applies to the southern tribe where the count (51.24) was higher than both in 1958, when it was unusually low (57.10) and in 1957 (57.22). Icelandic spring spawners had a lower count (57.18) than in the previous year (57.22), whereas the summer spawners (56.96) showed a higher figure (56.94). The average number of vertebrae for all tribes (57.15) was nearly the same as in 1958 (57.14).

If we compare the tribes, as is done in Table 5, where the differences are indicated under the heading B in relation to the standard deviation of the difference between the groups compared, it appears clearly that the spring spawning tribes cannot be distinguished by means of the total vertebral count. The summer spawners, on the other hand, seem to be entirely different from each of the other tribes.

Table 6 shows the number of vertebrae by maturity stages.

There is no significant difference between the vertebral counts of the different maturity stages, which suggests summer spawners were prominent

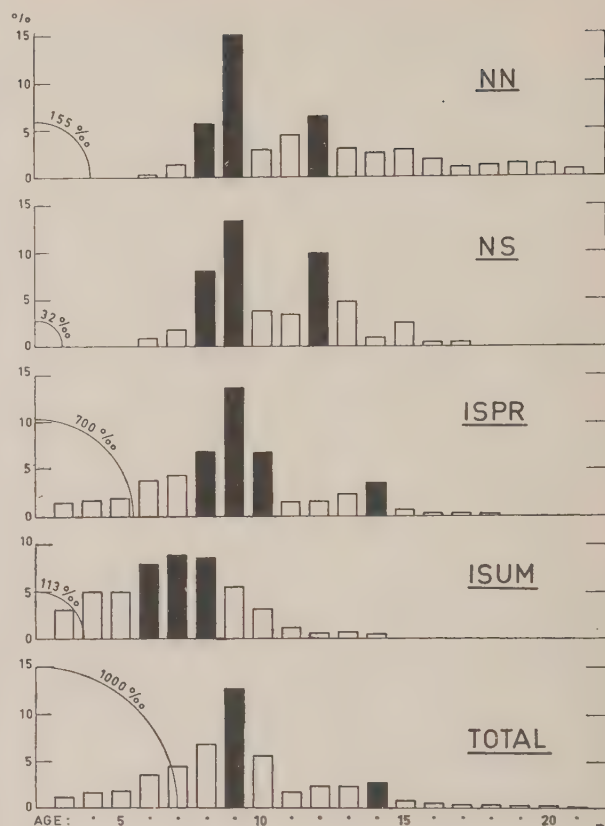


Figure 3. Age distribution in the different tribes in 1959, together with the relative number of fish in each tribe (circles at left).

Table 7. Average amount of *Calanus* (cm²) in the herring stomachs

Period	1959	1958	1957
June 11th-20th	4.5	9.4	11.0
June 21st-30th	7.8	10.6	9.1
July 1st-10th	10.9	6.3	10.5
July 11th-20th	11.1	4.8	6.6
July 21st-31st	14.4	8.1	3.4
August 1st-10th	10.3	9.5	0.9
August 11th-20th ..	11.0	10.0	0.0
August 21st-31st ...	8.5	0.0	0.0

in any single group. They were mostly confined to samples Nos. 33-34 and 37-38 (see Fig. 1).

A survey of the feeding conditions in comparison with the conditions in the seasons of 1958 and 1957 is given in Table 7. With exception of the first days of the season the feeding conditions seem to have been good throughout the summer. It is seen from the survey that in 1957 the amount of *Calanus* decreased rapidly just after the middle of July; in 1958 the decrease took place about a month later, and in 1959 there was a satisfactory quantity of food, at least until the end of August.

Table 8. Returns of tagged herring in 1959

Year	Returns A				Total
	North coast	East coast	South-west coast	Norway	
1950	2	—	—	—	2
1951	—	4	—	3	7
1952	15	3	—	3	21
1953	30	4	2	—	36
1954	24	—	2	3	29
1955	35	1	—	4	40
1956	48	7	5	2	62
1957	51	17	3	4	75
1958	2	42	—	1	45
1959	62	—	50	3	115
Total	269	78	62	23	432

Year	Returns B				Total
	North coast	East coast	South-west coast	Norway	
1951	—	1	—	1	2
1952	3	2	—	—	5
1953	1	2	—	3	6
1954	9	—	—	3	12
1955	8	—	—	1	9
1956	9	5	—	1	15
1957	5	15	—	2	22
1958	9	52	—	1	62
1959	32	—	5	—	37
Total	76	77	5	12	170

Year	Returns C				Total
	North coast	East coast	South-west coast	Norway	
1957	1	—	—	—	1
1958	—	1	1	—	2
1959	2	—	16	—	18
Total	3	1	17	—	21

A = Returns from N coast factories
 B = Returns from E coast factories
 C = Returns from SW coast factories

In accordance with the greater amount of food, the average index of intestinal fat was somewhat higher (1.7) than in 1958 (1.6) and 1957 (1.6), in spite of the fact that in 1959 the herring was in poor condition at the start of the season (1.3) owing to the scarcity of *Calanus*.

C. Tagging

Table 8 shows the number of internal tags returned from processing plants in all parts of Iceland in 1959. The total number, 623, was considerably higher than the highest number of returns in any previous year. In 1957 and 1958, 508 and 141 tags respectively were recovered. There was a greater number of Norwegian returns (37) than in any previous season. Considering the number of tags per 100,000 hl. of processed herring, there were totals of

45.8 tags, including 2.6 tags from Norway, in 1959
 34.3 tags, including 1.4 tags from Norway, in 1958
 49.6 tags, including 1.0 tags from Norway, in 1957.

The principal trend in the seasons 1957, 1958, and 1959 has therefore been towards more Norwe-

gian tags per unit weight of herring processed in the oil and meal factories. It is also noted that there were many returns (62) of tags from the SW coast in the north coast plants, and it is very interesting that most of them originated from taggings carried out in the spring of 1959.

During the German herring fisheries in the northern North Sea in 1958 and 1959, 6 tags from north coast liberations were returned.

During the period 12. to 24. July, 9,946 purse-seine caught herring were tagged internally and liberated (11 liberations) off the north coast.

Information as to the length of tagged herring is, unfortunately, not available.

Å. FRIDRIKSSON

The Norwegian Herring Fisheries in 1959

(Figure 4; Tables 9-10)

In 1958 the cold Baltic water had reached Stad before the arrival of the herring in the coastal water, and the main part of the herring stock was spawning north of Stad. In spite of good temperature conditions south of Stad during the season 1959, only a few schools were located there. It looks in the main as though the herring goes back to the spawning ground where it is hatched, but if there are unsuitable hydrographical conditions the herring have to find a new spawning ground, and it will in later years go to this new ground for spawning. This hypothesis gives a likely explanation of the trend in the Norwegian winter herring catches in recent years (see Fig. 4). The main catch has been taken further and further north, and, at the same time the herring have arrived later and later. The late arrival means a greater chance of meeting the cold front of Baltic water further north off the Norwegian west coast. The herring are stopped by the cold front, and must use more northerly spawning grounds where the environmental conditions are suitable.

If this hypothesis is correct the consequence will be very serious for the Norwegian winter herring seasons in the coming years. The already mature herring will not return to the southern grounds. At the same time there are very few recruit spawners and therefore very few herrings which have not already been stopped by the cold front. It means that the Norwegian herring fleet will have to concentrate on the fairly small spawning areas off Møre. This spawning ground is exposed to harder weather conditions than the grounds south of Stad.

The landings from the Norwegian herring fisheries in 1958 and 1959 are given in Tables 9 and 10.

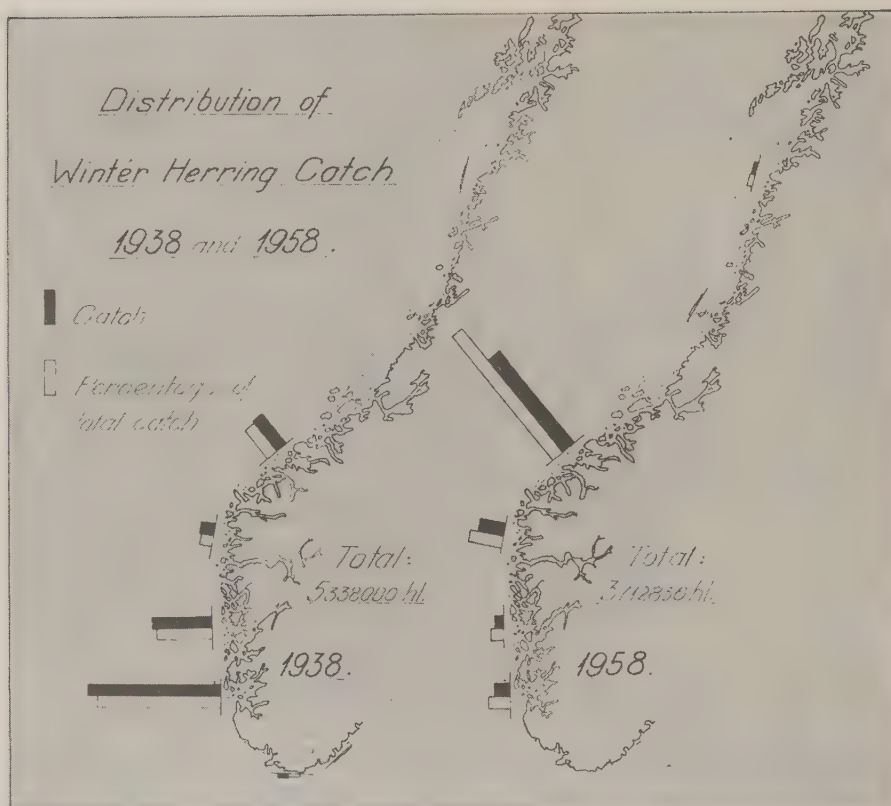


Figure 4.

Table 9. The Norwegian winter herring fishery in hectolitres

	1959	1958
Fresh export	992,022	742,535
Salted	861,745	862,097
Canned	172,165	101,406
Oil and meal	2,332,024	1,911,508
Bait	65,664	49,466
Consume fresh	53,118	45,482
Total	4,476,991	3,712,836

The great drop in the catch of the winter herring season off the Norwegian west coast in the three last years has made it necessary to a greater extent for Norwegian fishermen to join the herring fisheries in the North Sea.

The catch in the winter season 1959 was greater than in 1958 in spite of the stock calculations predicting a decline in the stock from 1958 to 1959. This is regarded as due to better hydrographical conditions during the season 1959. The surface layer had a higher temperature in 1959 than in 1958 and the herring schools were located higher in the sea. Thus the availability of the schools was higher, in spite of a decreased stock. Therefore the augmentation of the catch has to be regarded as apparent.

Table 10. Norwegian catch of herring from other areas in hectolitres

	Norwegian Sea	North Sea	Fat herring	Small herring
1958	587,822	88,032	578,040	1,556,679
1959	614,222	181,312	472,025	1,626,384

The Norwegian Sea was covered by a net of hydrographical stations from R/V "G. O. Sars" and "Johan Hjort" in January 1959, which made it possible to draw a fairly correct map of the Polar Front, and the migrating herring schools. The schools were followed by "G. O. Sars" to the Norwegian coast, and information about approach of the schools were given daily to the fishermen, who remained in port until the herring were within their reach.

In collaboration with Denmark, Iceland, and the Soviet Union, the Norwegian Sea and Icelandic waters were covered by a net of hydrographical stations in June. The research ships met in Thors-havn between 25. and 27. June and maps of temperature, plankton production, and concentrations of herring schools were made, based on the combined

observations. The maps of temperature and herring concentrations were later distributed among the Norwegian ships fishing herring in this area. These maps have proved to be very useful for the herring fleet.

In November and December, "G. O. Sars" covered the strategic area in the Norwegian Sea with a net of hydrographical stations and located the herring schools in the East Icelandic Current. The herring were located further west and north than usual in an area where the surface temperature was below 3.5° C, which made it possible to forecast late arrival of the herring in Norwegian waters in the season 1959.

FINN DEVOLD

Table 11. Length composition of Norwegian winter herring
(%)

A: Stages IV–VIII; B: Total (including stages I–III and herring with scales not fit for age determination)

cm	A		B	
	Purse-seine	Drift-net	Purse-seine	Drift-net
25.0	—	—	0.5	—
.5	—	—	—	—
26.0	—	—	—	—
.5	—	—	—	—
27.0	—	—	—	—
.5	—	—	0.5	—
28.0	—	—	0.5	—
.5	—	1	—	1
29.0	2	2	3	1
.5	3	2	4	2
30.0	6	7	8	9
.5	8	8	9	9
31.0	28	16	28	16
.5	36	34	35	33
32.0	77	72	78	70
.5	77	72	77	66
33.0	139	130	136	128
.5	113	111	110	109
34.0	145	156	140	154
.5	86	96	84	94
35.0	90	96	86	95
.5	50	47	50	47
36.0	56	56	60	62
.5	30	36	31	42
37.0	34	30	38	34
.5	11	16	12	16
38.0	5	9	6	9
.5	2	2	2	2
39.0	1	1	1	1
.5	1	—	0.5	—
40.0	—	—	—	—
Total	1000	1000	1000	1000
Number	2770	1818	3016	2090

Length, Age, and Spawning Groups of the Norwegian Winter Herring in 1959

(Tables 11–13)

The landings of winter herring by purse-seine and drift-net in 1959 amounted to nearly the same, 2.20 and 2.27 mil. hl. respectively, giving a total catch of 4.47 mil. hl. This shows an increase of 0.76 mil. hl., compared with 1958 which was the poorest season since the war. Less vessels participated in the fishery than in the previous season, 564 purse-seiners (1958 = 593) and 1,383 drifters (1958 = 1,562).

During the season from 26. January to 19. March, 48 samples, comprising 5,016 herring were examined. From analyses of the previous years' material it has been shown that the variation within the samples is less than the variation between the samples. For this reason the number in each sample have been reduced from 200 to 100 herring and the number of samples has been increased.

The length and age compositions of the samples from the purse-seine and drift-net landings are shown in Tables 11 and 12 and the distribution of spawning groups is given in Table 13. The average sizes of the herring from the purse-seine and drift-

Table 12. Age composition of Norwegian winter herring
Maturity stages IV–VIII (%)

Age	N.type	S.type	Total	N.type	S.type	Total
3	—	2	1	—	1	1
4	—	17	8	1	36	16
5	2	35	17	5	27	14
6	80	103	90	78	101	88
7	12	115	57	12	107	52
8	47	126	82	61	136	93
9	667	386	544	594	407	514
10	20	26	23	29	25	27
11	38	31	35	44	26	36
12	42	58	49	48	52	50
13	14	31	21	14	25	18
14	17	36	25	25	25	25
15	19	20	19	28	25	27
16	12	6	9	14	5	10
17	7	2	5	8	1	5
18	6	3	5	19	1	12
19	7	1	4	7	—	4
20	3	2	2	7	—	4
21	4	—	2	2	—	1
22	2	—	1	3	—	2
23	1	—	1	1	—	1
Total	1000	1000	1000	1000	1000	1000
No.	1544	1210	2754	1033	775	1808
Scales not fit for age determination			218			186
Immature (Stages I–III)			24			13

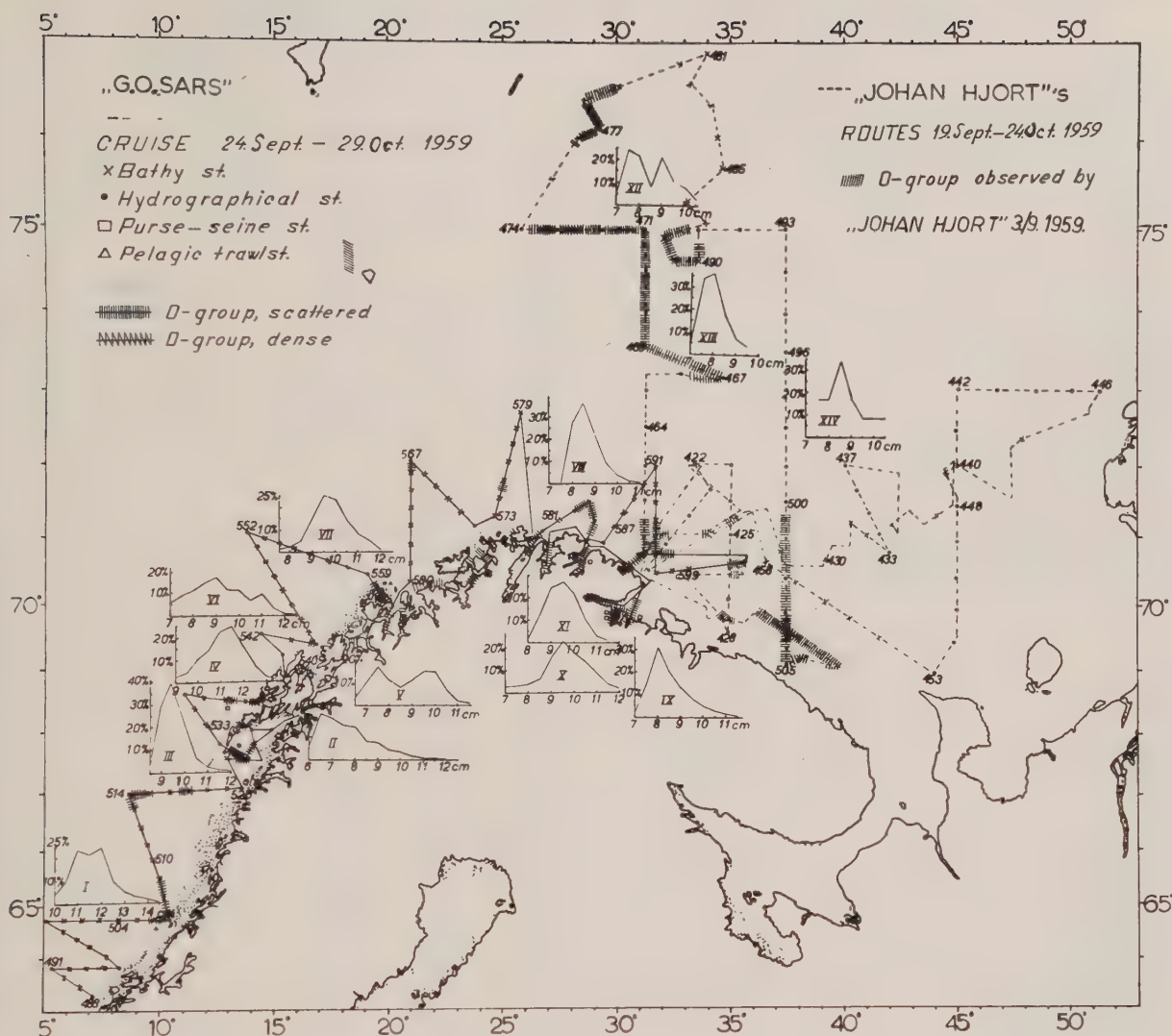


Figure 5.

The fat herring landed in southern Norway consisted almost entirely of the 1958 year-class, whilst the 1957 year-class predominated in the catches landed in northern Norway.

From the last week of September to the end of October a cruise was undertaken with "G. O. Sars" to the area off northern Norway and in the Barents Sea to investigate the distribution of the immature herring, especially the 0-group. In collaboration with "Johan Hjort" on cod investigation in the Barents Sea, with L. MIDTUN in charge, it was possible to get a fairly good survey of the distribution of the 0-group.

The routes of the two research vessels and the records of herring (0-group) obtained by asdic or echo-sounder are shown in Figure 5. "G. O. Sars" was equipped with purse-seine and pelagic trawl which made it possible to secure samples of the herring observed. The length distribution of the 0-group in the different areas is also shown in Figure 5.

Herring belonging to the 0-group was numerous both along the Norwegian coast and in the Barents Sea and the 1959 year-class therefore is expected to be above average.

OLAV DRAGESUND

Norwegian Tagging Experiments in 1959

(Tables 16-18)

Four categories of herring were tagged in 1959. The tagging localities and the number of each category tagged are listed in Table 16. The land-seine fishery was extremely poor in winter 1959, and it was impossible to secure live fish for large herring tagging.

Successful attempts were made to tag small herring (the 0-group) of a length ranging between 7.0—12.0 cm. All the herring were tagged with an internal steel tag. The dimensions of the tag are 15.0 × 2.0 × 0.5 mm, which is a little smaller than the tag introduced by FRIDRIKSSON and AASEN (1950). A new tagging gun was constructed for the insertion of the tag into the body cavity. Up to the end of 1959, 106 tags have been recovered from the different liberations.

In the summer of 1959, the Norwegian fishing fleet caught herring off North and East Iceland for

Table 16. Taggings in 1959

Area	Date	Number of liberations by type of tag	
Spring herring			
Brandasund (S of Bergen)	2-20. III.	15,500	13,950 internal 800 external 750 int. and ext.
"Forfangststild"			
Frænfjord (N of Kristian- sund)	11. IV.	225	200 internal 25 external
Frøyfjord (N of Kristian- sund)	17-20. IV.	2,350	2,300 internal 50 external
Sauøy (N of Trond- heimfjord)	23-27. IV.	3,350	2,950 internal 100 external 300 int. and ext.
Mausundvær (N of Trond- heimfjord)	30. IV.	500	internal
Vinsternes (N of Trond- heimsfjord)	6. V.	300	internal
Fat-herring			
Bugøyfjord (Varangerfjord)	20. X.	1,246	1,000 internal 246 external
Varangerfjord	20. X.	550	500 internal 50 external
Tanafjord	21. X.	450	350 internal 100 external
O-group			
Tysfjord	30. IX.	300	internal
Vestfjord	1. X.	600	internal
Røstbank	2. X.	1,000	internal
Torsvåg (N of Tromsø)	8. X.	2,000	internal
Jarfjord (Varangerfjord)	19. X.	600	internal

Table 17. Number of returns in 1958 and 1959 from the different experiments

Year of tagging	Category	Number tagged	Recaptures from:			
			The Norwegian winter herring season		The north and east coast herring season	
			1958	1959	1958	1959
1948 ...	NH	7,475	—	1	1	—
1951 ...	"	3,065	1	2	2	3
1952 ...	"	17,308	12	16	8	6
1953 ...	"	10,181	10	9	7	8
1954 ...	"	8,783	11	11	22	22
1955 ...	"	11,732	16	24	32	19
1956 ...	"	8,443	23	17	48	30
1957 ...	"	7,899	21	23	39	39
1958 ...	"	9,594	—	22	—	40
Total			94	125	159	167
1948 ...	SH	6,018	1	1	—	—
1949 ...	SH	8,261	1	4	1	—1
1950 ...	LH	9,085	1	5	—	—
1950 ...	SH	11,215	—	4	—	1
1951 ...	LH	5,998	1	5	—	—
1951 ...	SH	9,986	3	9	2	—
1952 ...	LH	10,295	2	1	—	1
1952 ...	SH	10,863	20	34	1	2
1952 ...	FH	7,971	4	3	—	—
1953 ...	LH	10,080	—	1	2	—
1953 ...	SH	10,046	3	9	—	1
1953 ...	FH	8,496	—	1	—	—
1954 ...	LH	10,042	4	5	—	1
1954 ...	SH	10,291	12	24	2	—
1954 ...	FH	14,970	5	5	—	—
1955 ...	LH	10,045	19	16	1	1
1955 ...	SH	9,087	4	6	—	—
1955 ...	FH	13,586	13	16	—	—
1956 ...	LH	4,998	4	7	—	1
1956 ...	FH	12,799	9	24	—	—
1957 ...	LH	9,500	16	16	—	2
1957 ...	SH	8,450	16	16	—	1
1957 ...	FH	3,900	6	4	1	—
1958 ...	SH	9,998	—	62	—	2
1958 ...	FH	6,200	—	6	—	—
Total			144	284	10	14

NH = North and east coast herring.

SH = Spring herring.

LH = Large herring.

FH = Fat herring and "Forfangststild"

the purpose of reducing it into oil and meal. A total of 328,574 hl. were landed at 22 different oil and meal factories in Norway, compared with 220,322 hl. landed at 15 factories in 1958. A comparison of the recaptures from this fishery with those from the Norwegian winter herring fishery is shown in Table 17. In 1959 a total number of 586 internal tags was received from the factories, 409 during the winter herring season, and 181 during the herring season off Iceland. The within season recoveries and tags received from factories which do not possess magnets have not been taken into consideration.

Out of 409 recovered tags during the winter herring season, 284 were released as spring and large herring, "forfangstsild", and fat herring; 125 were tagged as north coast herring.

The composition of the recaptures off Iceland shows the same general pattern as in 1958 (Table 17). Out of 181 recovered tags, 167 were released off North and East Iceland, whereas only 14 were tagged off the Norwegian coast.

The recaptures of north coast tags (I-tags) per mil. hectolitres in Norwegian waters have decreased greatly during the last five years (Table 18). The reason for this decrease may be the relatively large number of Icelandic spring spawners which have been present off North Iceland during the tagging experiments in these years.

Table 18. Returns of I-tags in Norwegian waters

Year of tagging	Year of return	Returns	Returns per mil. hl. in ‰
1952	1953	257	4.38
1953	1954	282	4.79
1954	1955	122	3.02
1955	1956	159	3.18
1956	1957	89	2.74
1957	1958	21	2.65
1958	1959	22	1.52

According to FRIDRIKSSON (1956 and 1958) Icelandic spring spawners contributed 4.2—17.1% of the total catch during the period 1949—1953, compared with 39.1—58.7% during the period 1954—1957.

OLAV DRAGESUND

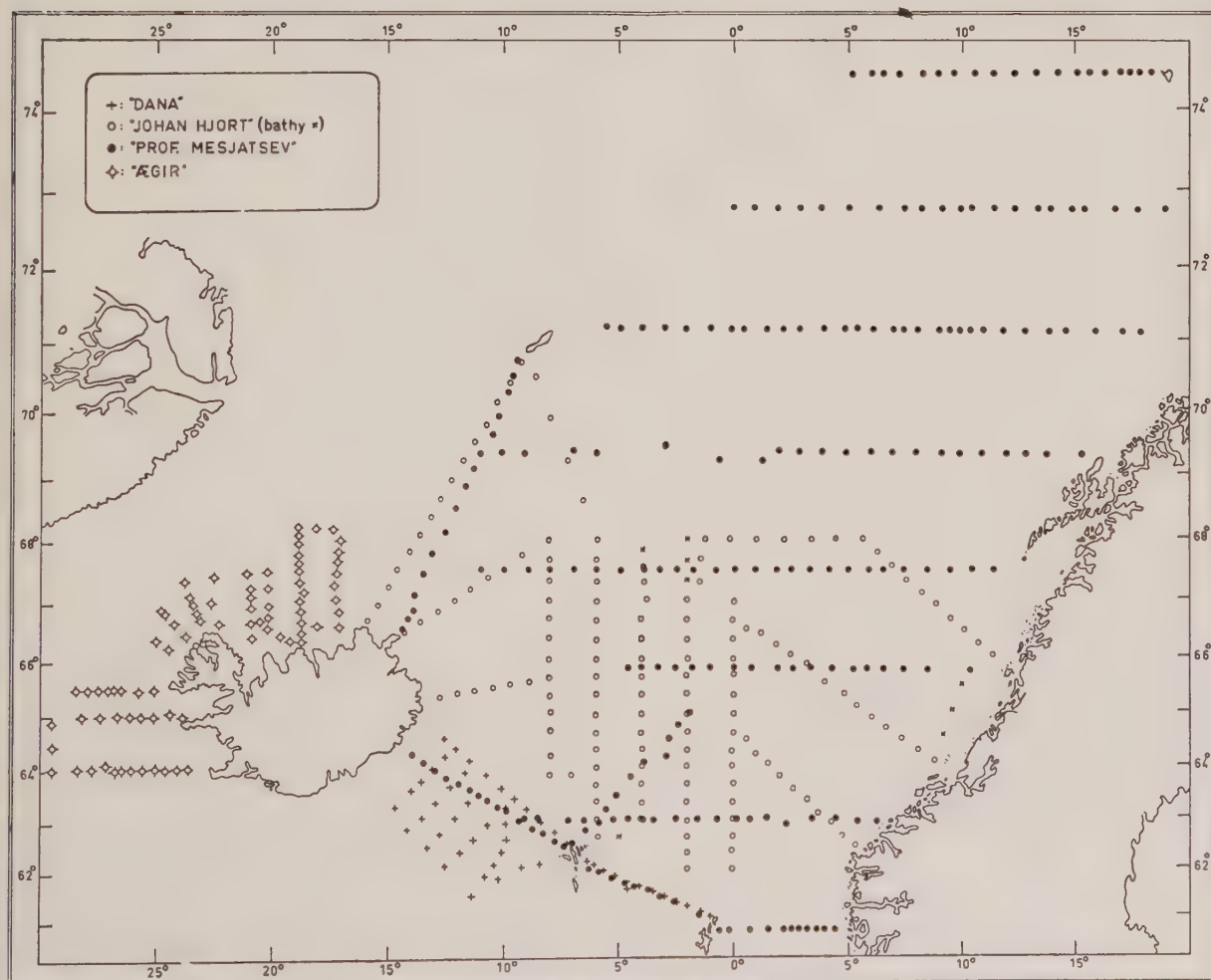


Figure 6. Location of stations.

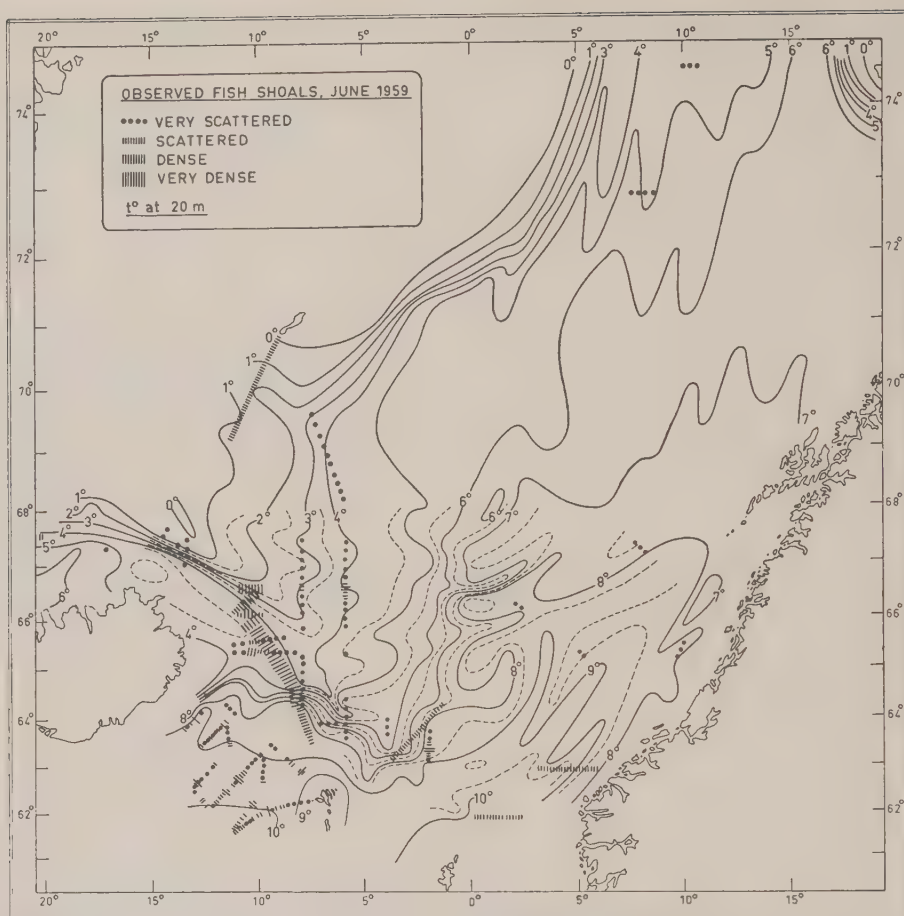


Figure 7. Concentration of fish shoals and distribution of temperature at 20 m.



Figure 9. Distribution of phosphate at 10 m.

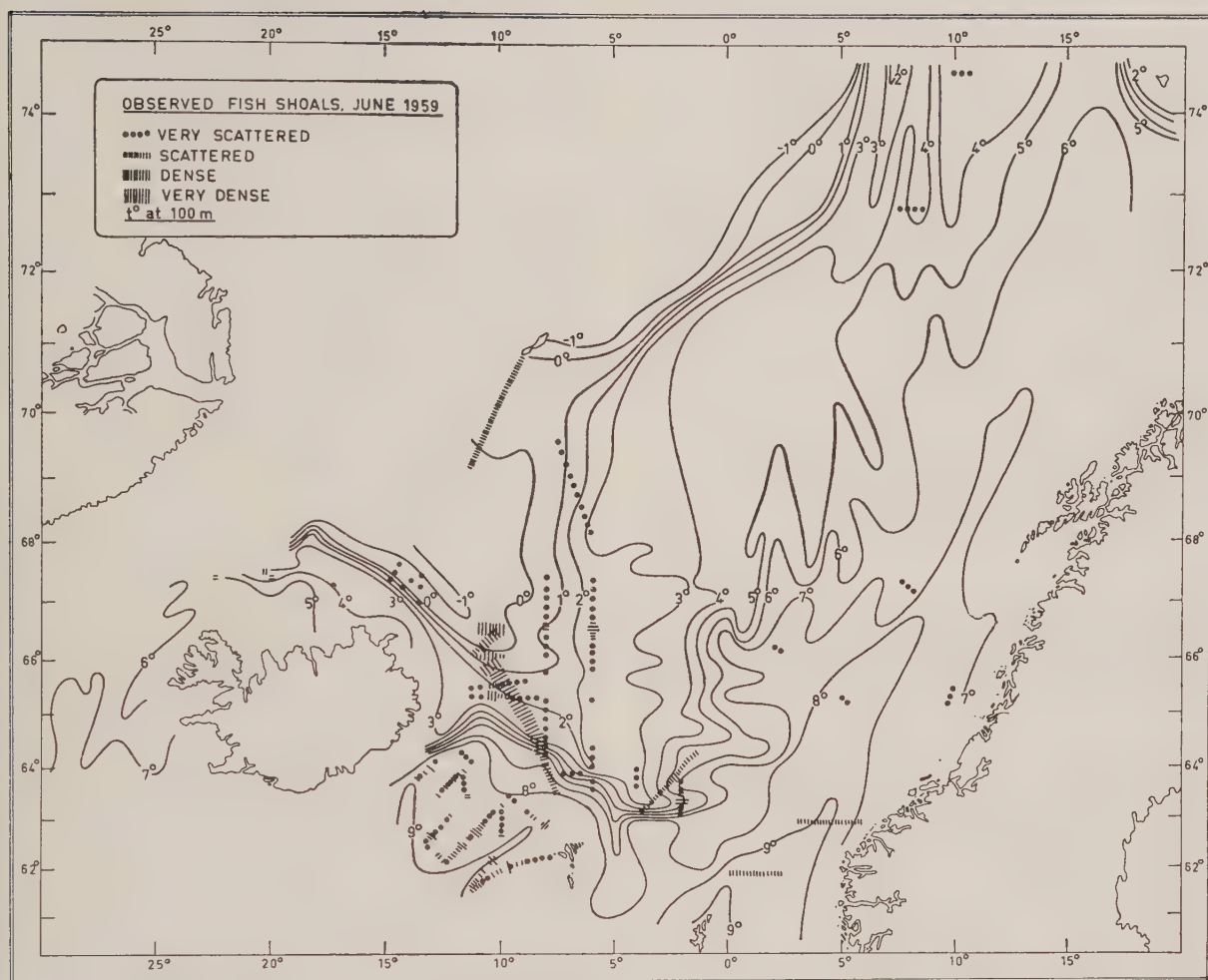


Figure 8. Concentration of fish shoals and distribution of temperature at 100 m.

International Herring Investigations in the Norwegian Sea, June 1959

(Figures 6–9)

The four countries Denmark, Iceland, Norway and the USSR agreed in the last meeting held in Seydisfjord, Iceland in late June 1958, to continue joint investigations in the Norwegian Sea and Icelandic waters in June 1959. The original plan was that the research ships should meet in Siglufjord, Iceland. However, this meeting place was not suitable for the Danish scientific staff and therefore the ships, with the exception of the Icelandic research ship, met in Thorshavn between 29. June and 1. July.

The Soviet research ship "Professor Mesjatsev", with Professor Yudanov in charge covered the area from Bear Island to the Polar Front and southwards to the Faroe-Shetland Channel. The Norwe-

gian research ship "Johan Hjort", with Mr. F. DEVOLD in charge, covered the main part of the area between 63° and 68°N and also the area between Jan Mayen and NE Iceland. The Icelandic research ship "Ægir", with Dr. HERMANN EINARSSON in charge, covered the area west of Iceland and between the ice-border and the north coast of Iceland. During the period of investigation two surveys were made. The Danish research ship "Dana", with Mr. F. HERMANN in charge covered the Iceland-Faroe Ridge and the area west of this ridge.

During the cruises fish shoals were recorded by means of asdic and echo-sounder from "Professor Mesjatsev", "Ægir", and "Johan Hjort" and by means of echo-sounder only from "Dana".

Figures 6–9 show the location of stations, the distribution of fish shoals, and the temperatures at

20 and 100 metres, and also the phosphate distribution at 10 m.

The greatest concentrations of herring were found along the Polar Front east of Iceland. The concentrations of herring were smaller than in previous years, especially in the northern part of the Norwegian Sea. Only small concentrations were found in the area north of Iceland. It appears that the main concentrations of herring during June, were located along the southern and western border of the East Icelandic Current.

Reports on the plankton and the hydrographical situation in this area are found elsewhere in this volume.

Members of the Herring Committee:

F. DEVOLD, Norway, "Johan Hjort"

H. EINARSSON, Iceland, "Ægir"

J. JOENSEN, Faroe, "Dana"

I. G. YUDANOV, USSR, "Professor Mesjatsev"

Les Recherches Soviétiques Concernant le Stock, la Distribution et la Conduite des Harengs Atlanto-Scandinaves

(Figure 10)

Pour l'année 1959 on n'a pas pronostiqué un recrutement considérable du stock commercial des harengs atlanto-scandinaves par les classes plus jeunes, ces dernières étant peu nombreuses. C'est pourquoi la richesse du stock commercial était évaluée comme bien moins importante par rapport au stock commercial des années précédentes quand les riches classes de 1943, 1944, et 1947 faisaient une partie considérable de la pêche ainsi que la classe de 1950 extrêmement nombreuse. Le pronostic a indiqué que la proportion des classes dominantes de 1950 et 1951 dans les captures de 1959 retiendra le niveau de l'année précédente, c. à d., 50% et, avec cela la classe de 1950 devrait être essentielle durant toutes les saisons de pêche.

Les explorations concernant l'étude des ressources de la pêche harengière dans la partie SE de la Mer de Groenland, dans la Mer de Norvège et au nord de la Mer du Nord ont été effectuées par les navires de recherches scientifiques l'«Académicien Bergue», le «Professeur Messiatsev» et par les bateaux-pilotes de pêche. Outre cela on a relevé les particularités les plus importantes des conditions de la pêche au cours des travaux océanographiques collectifs qui ont été réalisés en juin 1959 dans la Mer de Norvège par les navires océanographiques de la Norvège, du Danemark, de l'Islande et de l'Union Soviétique.

L'une des particularités les plus caractéristiques du régime hydrologique de 1959 en comparaison avec l'année précédente est celle que l'afflux des eaux atlantiques à travers le canal de Féroes-Shetland est devenu beaucoup plus intense, ce qui s'est surtout manifesté dans le flot principal du courant de Norvège le long de la branche orientale qui longe la pente du plateau continental.

Les recherches portant sur le plancton ont montré qu'en 1959 le développement des processus, de printemps liés avec sa reproduction dans les eaux atlantiques de la partie sud de la Mer de Norvège a commencé un mois plus tôt qu'en 1958 et 1957. D'après les données recueillies au mois de mai on peut voir assez clairement qu'en ce temps-là les conditions étaient très favorables pour l'engraissement du hareng au sud de la Mer de Norvège. La plus grande quantité de la nourriture pour le hareng fut surtout trouvée dans les eaux mixtes, près des limites du courant de l'Islande orientale.

Les conditions de la pêche se distinguaient de ceux des deux années précédentes par une diminution considérable de la zone de répartition du hareng au cours de la période de l'engraissement intense. En ce temps-là il n'y avait pas de progressions considérables des concentrations faisant l'objet de la pêche non seulement dans les régions du nord, contigues à Spitsbergen de l'ouest, mais aussi dans la région du seuil Mona. L'extrême limite nord de la répartition de hareng ne s'étendait pas plus loin que la latitude de Jan Mayen jusqu'au massif sous-marin No. 774.

L'engraissement le plus important du stock de hareng avait lieu, pour la plupart, dans les eaux mixtes du «front polaire» et dans les eaux polaires des courants de l'Islande orientale et en partie du courant de la Groenland orientale qui y sont contigues. Dans une vaste région qui embrasse certaines branches du courant chaud de Norvège on n'avait pas trouvé de concentrations de hareng au mois de juin, quand le hareng est largement répandu.

La sortie en masse de hareng engraisé des eaux polaires s'était, généralement, terminée à la fin du mois de septembre. A l'époque d'automne et d'hiver, c. à d., du mois d'octobre jusqu'au mois de décembre y compris, des concentrations de hareng aux stades de maturité des organes génitaux IV et IV—V étaient principalement répandues le long de la limite orientale de la partie des eaux mixtes du courant de l'Islande orientale.

A la même époque ces eaux s'étaient beaucoup plus déplacées vers l'ouest et vers le nord que les 5 années précédentes. La région des concentrations de pêche était devenue trois fois moins grande à

cette époque qu'au cours de l'année 1955. Du à ce fait leur masse principale se trouvait à des profondeurs beaucoup plus grandes que durant les autres années. Cela empêchait la pêche au filet dérivant, surtout au mois de décembre, où les plus grandes concentrations se trouvaient seulement dans la profondeur de 80—100 m de la surface.

La cause principale de la diminution de la zone de répartition de hareng au moment où l'engraissement est le plus intense et celle de la diminution de la zone de répartition des concentrations prêtes à la ponte au printemps et en hiver consiste en la diminution brusque de l'abondance générale du stock des harengs atlanto-scandinaves, et n'est pas du aux changements des conditions du milieu d'habitation. Cela est arrivé parce qu'à partir de 1954 les captures principales des flottes harenguières de la Norvège et de l'URSS étaient composées du hareng de la classe de 1950. En même temps les classes très importantes de 1943, 1944 et 1947, à l'âge de plus de 9 ans, ont perdu, peu à peu, leur signification pour la pêche. Tous les classes annuelles plus jeunes, qui ont fait leur apparition après 1951, étaient moins importantes et ne pouvaient pas compenser la perte, conditionnée par la mort naturelle et par la pêche.

L'examen des changements généraux de la composition des classes annuelles et des analyses quantitatives des différentes classes annuelles du stock des harengs atlanto-scandinaves nous amène à constater les faits suivants: on peut apprécier les ressources de pêche pour 1960 comme moins satisfaisantes en comparaison avec celles des deux années précédentes. La zone des migrations et celle de la pêche se diminueront aussi. Les classes de 1950 et de 1951 feront la partie la plus importante des captures. Leur présence, même à l'âge de 9—10 ans, sera dominante dans toutes les saisons parmi les classes plus âgées et les classes plus jeunes, et la classe de 1950 gardera sa supériorité comme au cours des six années précédentes. D'ailleurs, en même temps que la quantité de hareng de ces classes aura diminuée, l'abondance relative des classes plus jeunes, bien que moins nombreuses, peut s'accroître dans les captures d'une manière assez évidente. En se basant sur l'état général du stock des harengs immatures analysé durant les 15 dernières années on a donné le pronostic concernant les perspectives du recrutement du stock commercial pour les régions ouvertes de la Mer de Barentz aussi que pour la zone côtière de Mourman. On suppose que dans les zones ouvertes de la Mer de Barentz la classe la plus abondante de 1957 en 1960 quittera presque complètement la zone côtière et se répartira le long de la branche côtière

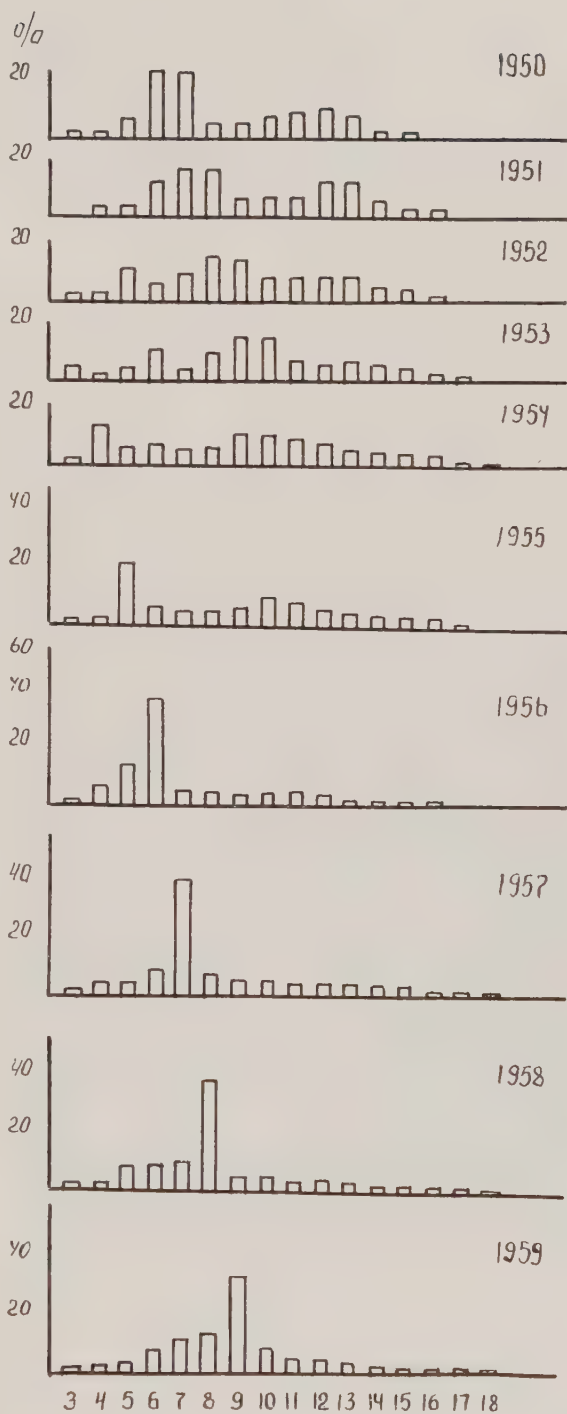


Figure 10. Composition de la taille de l'hareng atlanto-scandinave (suivant les données obtenues de l'Institut PINRO).

et de la branche principale du courant de Mourman. C'est le hareng de la classe annuelle de 1959, qui sera dominant parmi le hareng de petite taille dans des limites de différentes baies et golfes. Cette classe est très répandue dans toute la Mer de Barentz, mais son abondance dans quelques régions cède considérablement à celle de la classe de 1953.

Cette dernière était beaucoup plus nombreuse durant la première année de sa vie dans la zone côtière de Mourman, ce qui a été constaté au cours de l'analyse quantitative des stades jeunes des principales espèces de poisson de pêche à l'aide de chalut.

I. G. YUDANOV

B. Near Northern Seas

YOUNG STAGES

Autumn Spawned Herring Larvae in the Northern North Sea in 1959

Scottish sampling of autumn spawned herring larvae in 1959 was planned to cover the area from $56^{\circ}00' N$ to $58^{\circ}30' N$ and from the Scottish coast to $1^{\circ} E$. The programme was heavily curtailed by bad weather, particularly in the last three months of the year. As a result effective surveys were obtained only during the following periods: 12.—17. September, 17.—22. September, 7.—25. November.

On the first two surveys, which took place at the normal time of the main hatching period in this area, recently hatched larvae were found over a wide area to the north and east of Orkney and into the northern Moray Firth, in the Kinnaird Head region, on Turbot, Aberdeen, and Montrose Banks. These small larvae, although less plentiful in the Orkney area than in 1958 were still much more abundant than in other recent years. On the more southerly spawning grounds they were more

abundant than in 1958 but not above the average of other recent years.

Two features distinguished the distribution of the larger larvae on the first two surveys; a much wider spread of larvae eastwards in the Orkney area, where they were taken in considerable abundance east to $1^{\circ} W$; and a less extensive southerly spread from the Buchan area where larvae were quite scarce south of $56^{\circ}30' N$. With only one survey after mid-September no firm conclusions can be formed regarding their subsequent dispersal. On the November survey larvae were fairly widely distributed over the area from $58^{\circ}30' N$ to $55^{\circ}30' N$ and east to the prime meridian. This suggests a smaller component of easterly drift than normal. However, the outstanding feature of this survey was the scarcity of larvae compared with cruises at the same time in previous years and it may be that the main body of larvae had already moved out of the survey area.

A. SAVILLE

COMMERCIAL FISH

The German Oil Herring Fishery in 1959

(Table 19)

In 1959, the total yields of the German oil herring fishery amounted to 40,773 metric tons, and exceeded 40,000 tons for the second time since its beginning in 1951. This catch contained an estimated 787 million herring. While the first oil herrings were caught in April in the Botney Ground area, more than 95% of the total landings were obtained during the usual catching season from July to October and from the known fishing grounds, i. e., Weisse Bank, Cleaver Bank, Clay Deep, and western Dogger Bank. The average catch per trip, from the 1,254 fishing trips, amounted to 32.5 tons and was thus higher than in all previous years (1958 = 29.8; 1957 = 19.4 tons).

As in previous years, the composition of the catch was studied. Eight samples, comprising 2,305 fish were analysed as to their species and length composition. The length composition of 1,509 fish is given in Table 19.

Owing to the dense concentration of the herring on the fishing grounds, the by-catches of non-clupeid fish were relatively small and amounted only to 6.8% of the total catch. The total catch was composed on average of 85.8% herring, 7.4% sprat, 5.5% whiting, 0.1% haddock, 0.1% dab, and

1.1% of other fish such as gurnard, mackerel, etc. However, only 1.0% of the catch consisted of undersized, protected fish. These were nearly all whiting, measuring less than 20 cm.

P. F. MEYER-WAARDEN

The Winter Fishery for Juvenile Herring
in the Coastal Waters of Niedersachsen in 1958/59

(Tables 20-21)

For more than 40 years a winter fishery for sprat and juvenile herring has existed on the coast of Niedersachsen. The available catch statistics, starting in 1921, show that the largest annual yield ever obtained, amounting to nearly 3,000 metric tons was in 1926. In recent years, the largest quantity, 2,780 tons, was caught in the 1951/52 season. Since 1953/54 catches have been less than 1,000 tons. In former years the favourite fishing gear was the "stow" net, two of which were usually operated from an anchored vessel. For the past four years, however, fishermen are mostly using trawl nets, both bottom and pelagic pair trawls as well as otter board trawl nets. In view of the unstable catch situation in the shrimp fishery (March/October) which is the main fishery of these fishermen, the government is encouraging winter fishing on this coast, in order to raise the socio-economic standard of the local fishing communities, which are largely dependent on the coastal fisheries, due to the lack of other industries.

In the 1958/59 fishing season (October 1958 to March 1959) 50 small fishing boats, measuring 11—15 m overall length, participated in this fishery. Their total catches amounted to 652.8 tons of juvenile herring, estimated at some 66 million fish, and to 99.7 tons of sprat.

In co-operation with Dr. SCHUBERT, 6 samples, totalling 1,696 herring were examined for length composition and meristic characters (Table 20) and 4 fish for fat content (Table 21).

Table 21. Fat content of juvenile herring

Sample	Date	Length cm	Weight g	Fat content %
1	6. Feb. 59	11.6	7.9	1.8
2	"	12.3	10.4	3.5
3	"	15.6	18.8	4.8
4	"	17.0	22.8	5.5

K. TIEWS

Table 19. Length composition (‰) of German oil herring catch in 1959

Month Samples	April 1	July 2	August 3	September 2
Locality	E of St. 2	Weisse Bank	Weisse Bank Cleaver Bank Clay Deep	Clay Deep
Depth cm	45-48 m	40-46 m	38-50 m	50 m
10	—	7	—	—
11	3	7	—	—
12	5	17	27	17
13	102	14	77	32
14	239	7	67	107
15	266	7	18	124
16	198	118	49	52
17	66	270	322	104
18	83	304	265	283
19	19	159	93	141
20	14	52	38	65
21	—	28	27	55
22	5	10	15	15
23	—	—	2	5
Number	364	289	453	403

Table 20. Length composition and meristic characters of juvenile herring from coastal waters of Niedersachsen.

Sample	1	2	3	4	5	6	a	b	= S	I—6
Date	3. Dec. 1958	30. Jan. 1959	6. Feb. 1959	9. Feb. 1959	13. Feb. 1959	2. Mar. 1959				
cm										
7.5	—	—	—	—	—	—	1	1	1	1
8.0	—	—	—	—	—	—	1	1	1	1
8.5	—	—	—	—	—	—	—	—	—	—
9.0	—	—	—	—	—	—	8	8	8	8
9.5	2	—	—	—	—	—	10	10	10	12
10.0	4	—	—	7	—	—	22	22	22	33
10.5	8	—	3	19	—	2	41	43	43	73
11.0	11	—	5	19	4	12	37	49	49	88
11.5	21	4	17	11	14	24	33	57	57	124
12.0	22	8	34	19	21	22	29	51	51	155
12.5	19	27	68	12	54	24	33	57	57	237
13.0	7	52	72	8	37	8	11	19	19	195
13.5	5	48	62	3	40	7	9	16	16	174
14.0	1	44	53	2	41	1	1	2	2	143
14.5	—	35	31	—	40	—	—	—	—	106
15.0	—	31	21	—	27	—	—	—	—	79
15.5	—	22	14	—	30	—	—	—	—	66
16.0	—	18	10	—	19	—	—	—	—	47
16.5	—	10	10	—	22	—	—	—	—	42
17.0	—	9	7	—	12	—	—	—	—	28
17.5	—	10	3	—	16	—	—	—	—	29
18.0	—	9	3	—	8	—	—	—	—	20
18.5	—	9	1	—	3	—	—	—	—	13
19.0	—	9	—	—	2	—	—	—	—	11
19.5	—	5	1	—	1	—	—	—	—	5
20.0	—	3	1	—	—	—	—	—	—	4
20.5	—	—	—	—	1	—	—	—	—	1
21.0	—	—	—	—	—	—	—	—	—	—
21.5	—	1	—	—	—	—	—	—	—	1
n	100	354	415	100	391	100	+ 236	= 336		1696
Mean length	12.04	14.92	13.82	11.81	14.55	12.3	11.52	11.75		13.58
V.S. mean	56.511			56.545		56.604				
Standard error	±0.065			± 0.061		± 0.060				
K ₂ mean	14.913			15.061		15.021				
Standard error	±0.103			± 0.089		± 0.090				

Fishing grounds:

- Sample 1 = Buchtloch near Neuwerk
 2 = SW P 12, 30—35 m.
 3 = Between J/E 6 and 7, 20—25 m.
 4 = Weser Estuary, 20 m.
 5 = Near Baltrum/Langeoog, 17—20 m.
 6 = Near Langeoog, 17 m.

Table 22. Statistics of "halflin" fisheries in 1954/59

	Season				
	1954-55	1955-56	1956-57	1957-58	1958-59
	Upper Moray Firth				
Duration of season . . .	18/9/54-26/3/55	1/10/55-31/3/56	6/10/56-9/2/57	14/9/57-22/2/58	11/10/58-7/2/59
No. of landings	1,715	2,989	2,274	891	710
Total catch (crans) . .	25,263	61,945	34,605	5,715	5,407
Catch/landing (crans) . .	14.7	20.7	15.2	6.4	7.6
	Upper Firth of Forth				
Duration of season . . .	18/10/54-23/3/55	24/9/55-31/3/56	8/9/56-16/3/57	21/9/57-19/4/58	10/11/58-21/3/59
Greatest number of boats engaged	22	16	16	22	16
Estimated catch of "half-lins" (crans)	786	379	328	3,352	1,310
Estimated catch of "half-lins" per arrival (crans)	5.46	12.53	6.31	7.56	6.45

Table 23. Length and mean Vert. S. of O- and I-group herring in the inshore waters off the Scottish east coast in 1958/59

Locality	Date	(Numbers in brackets)		
		Range (cm)	Mean length (cm)	Mean Vert. S.
Firth of Forth ¹⁾	Autumn 1957 and Spring 1958 Broods			
	Dec. 1958	9-16	12.84 (180)	56.53 (58)
Firth of Forth ¹⁾	Autumn 1956 and Spring 1957 Broods			
	Nov. 1958	18-24	21.07 (148)	56.57 (97)
	Dec. 1958	17-23	19.36 (28)	56.60 (25)
	Jan. 1959	20-24	21.80 (45)	56.50 (44)
	Feb. 1959	18-24	21.27 (90)	56.49 (89)
Upper Moray Firth ²⁾	Oct. 1958	20-24	21.57 (90)	56.56 (90)
	Nov. 1958	18-24	21.23 (332)	56.57 (329)
	Dec. 1958	19-23	21.05 (98)	56.51 (95)

¹⁾ Samples caught by ring-net.²⁾ Samples caught by drift-net.O- and I-Group Herring Fisheries in Scotland
in 1958/59

(Table 22-23)

The catch and effort statistics for the "halflin" fisheries in the Firth of Forth and in the upper Moray Firth during the season 1958/59 are given in Table 22. The density of the stock in both areas was much the same as in the previous season.

The size range, mean lengths, and mean Vert. S. of samples of O- and I-group herring from these commercial fisheries are given in Table 23. From the vertebral counts it appears that the "halflin" stock consisted mainly of autumn spawners.

G. MCPHERSON

Table 24. East coast and Shetland landings 1956-1959

	Landings (crans)				Arrivals				Average landing per arrival ¹⁾ (crans)			
	1956	1957	1958	1959	1956	1957	1958	1959	1956	1957	1958	1959
	1956	1957	1958	1959	1956	1957	1958	1959	1956	1957	1958	1959
Fraserburgh . .	84,831	75,704	54,835	131,012	3,811	4,226	2,552	5,845	22.3	17.9	21.5	22.4
Peterhead . . .	54,337	50,014	21,955	44,746	1,720	2,334	1,064	1,634	31.6	21.4	20.6	27.4
Lerwick	42,019	39,380	40,092	40,772	1,966	1,483	1,718	1,499	21.4	26.6	23.3	27.2
Wick	2,325	44	239	68	57	11	29	9	40.8	4.0	8.2	7.6
Aberdeen . . .	58,996	60,939	49,883	49,784	858	950	862	965	68.8	64.2	57.9	51.6
Trawl												
	Landings (crans)				Hours fishing				Landing per 100 hours (crans)			
	1956	1957	1958	1959	1956	1957	1958	1959	1956	1957	1958	1959
North-eastern North Sea . .	1,254	959	2,086	948	310	310	1,064	276	404.5	309.4	196.1	343.5
Fladen	2,721	906	4,709	1,010	1,269	400	2,694	491	214.4	226.5	174.8	205.7
Gut and southwards .	4,625	6,199	518	—	1,850	2,136	194	—	250.0	290.2	269.8	—

¹⁾ These figures are not adjusted to standard number of nets per haul. Each arrival at Aberdeen represents on average two hauls, each arrival at other drift-net ports usually only one haul.

Scottish Fisheries in 1959

(Figures 11-14; Charts 1-12; Tables 24-28)

A. North Sea
The Fisheries

Drift-net

Drift-net fishing was carried out from the following Scottish ports during 1959: Aberdeen (April to mid-September), Fraserburgh (mid-April to mid-September), Peterhead (May to mid-September), and Lerwick (mid-May to August). There were occasional landings at Wick.

The catch and effort statistics for the fisheries from these ports in 1959 and in the previous three years are given in Table 24 and the detailed monthly statistics of catch and effort in each 10 mile square for all fisheries combined are shown in Charts 1-12. Charts 1-6 give the number of hauls per month in each square and Charts 7-12 the corresponding average catch per 100 net-haul.

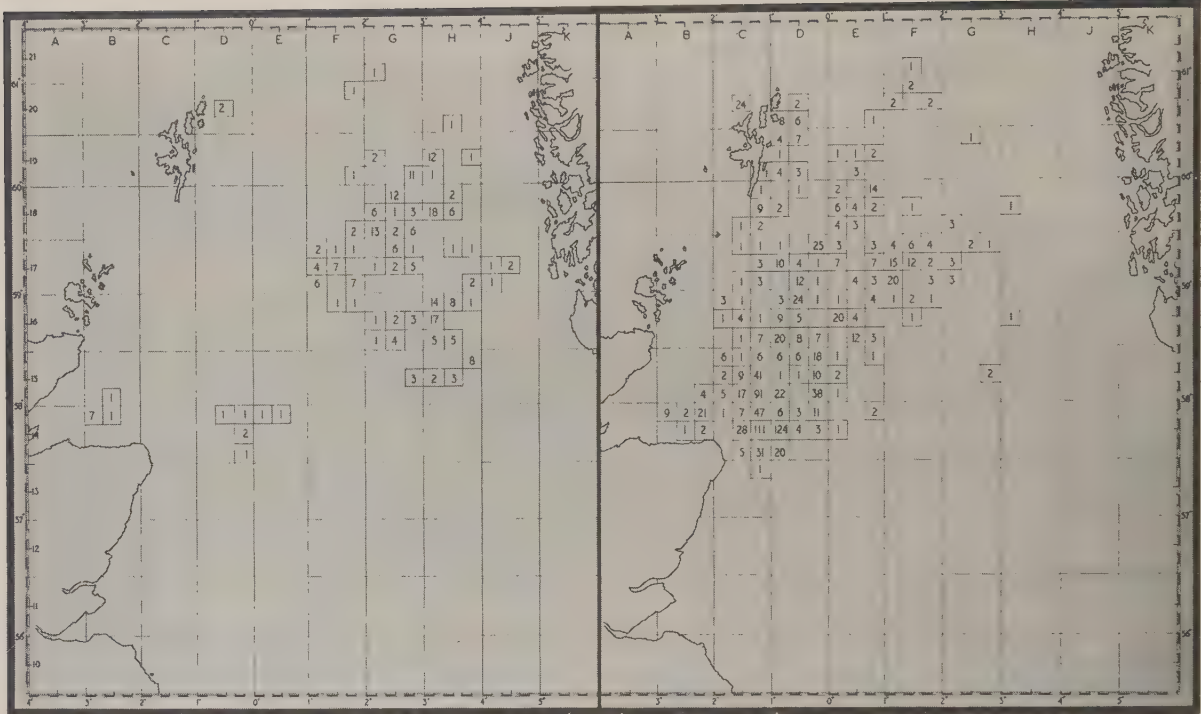
Landings at Fraserburgh and Peterhead in 1959 were more than twice the 1958 landings, due to consistently good fishing between May and the middle of August on the traditional Buchan grounds within 60 miles of the ports. This was in sharp contrast to 1958 when the fishery on these grounds was very poor (Ann. Biol., 15).

Trawl

Trawlers, mostly from Sweden, made regular landings from the north-eastern North Sea in October 1959 and irregular landings from the Fladen Ground between July and October. There were no landings from the Gut area.

The catch and effort statistics for these fisheries in 1959 and the previous three years are given in Table 24. The catch per unit effort in both areas was higher than in 1958.

Number of Hauls



Charts 1-2.

March/April

May



Charts 3-6.

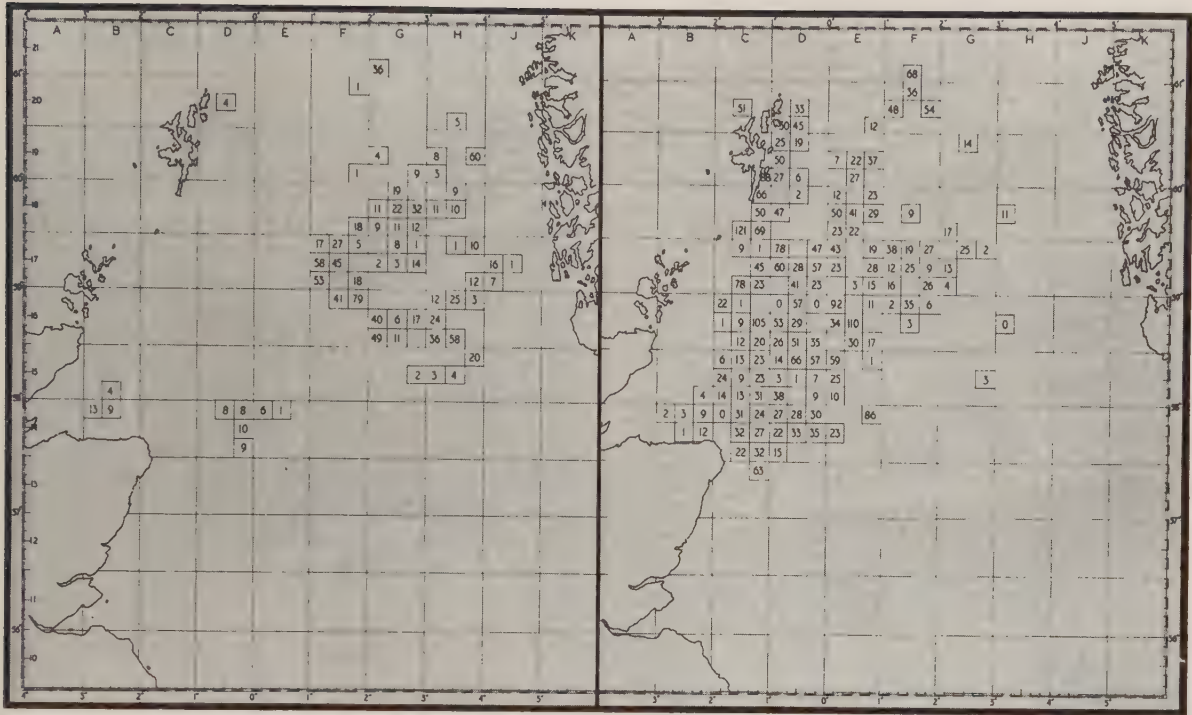
June

July

August

September

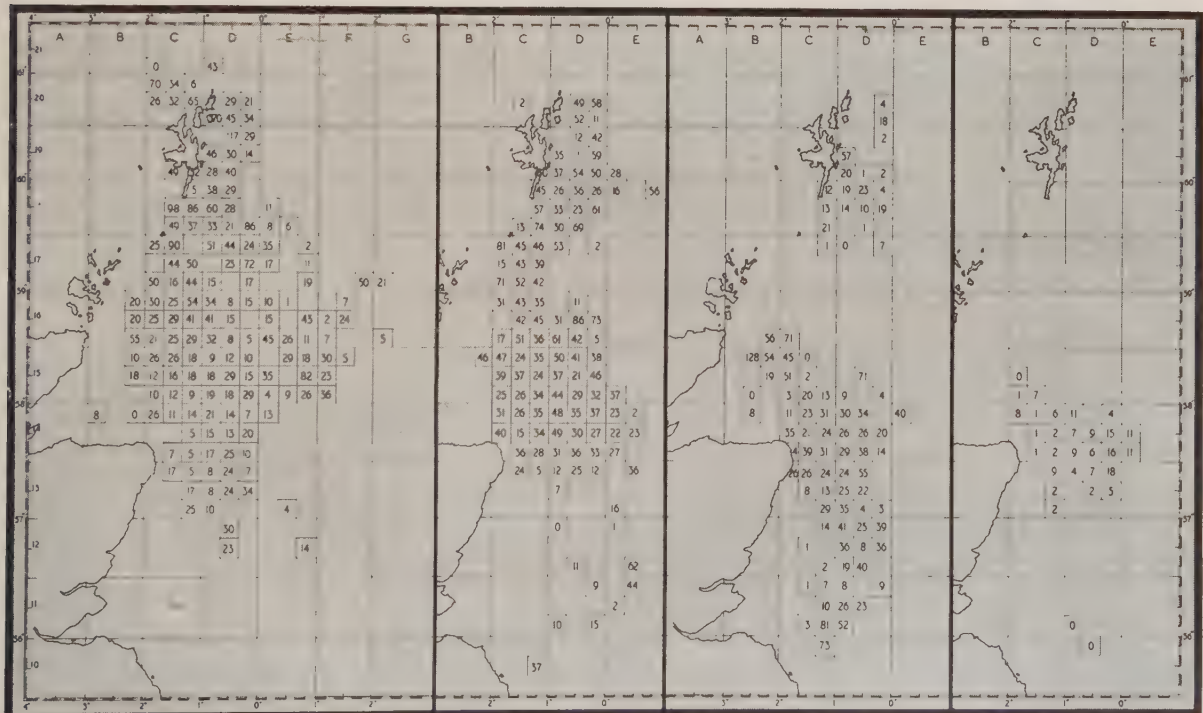
Catch per Haul



Charts 7-8.

March/April

May



Charts 9-12.

June

July

August

September

NORTH-EASTERN NORTH SEA DRIFT 1959

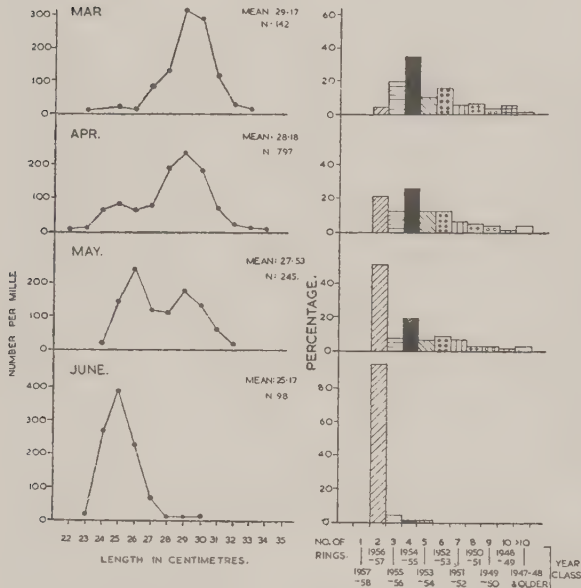


Figure 11. Length and age composition of north-eastern North Sea drift-net samples March–June 1959. (Length frequencies unsmoothed).

Biological Data

Sampling of the drift-net landings at Aberdeen, Peterhead, Fraserburgh, and Lerwick was carried out as in previous years.

North-eastern North Sea (grounds east of 1°E)

The length and age composition of the combined samples taken in the north-eastern North Sea between March and June 1959 are shown in Figure 11; the maturity and Vert. S. data are given in Table 25, and the age compositions of the spring and autumn spawned groups, separated on otolith characters, are given in Table 26.

These data show a difference between the composition of the catch in this area in 1959 and that in previous years. Fish with 2 winter-rings, which usually form a very small proportion of the catch, were prominent in 1959 among both autumn and spring spawners and made up 29% of the sampled catch. Otherwise the general pattern was unchanged, with the spring spawning component consisting mainly of the younger age-groups and the autumn spawning component of a wider range of ages in which the 4-ringed 1954 brood and the 6-ringed 1956 brood were again prominent (Ann. Biol., 15).

North-western North Sea (grounds west of 1°E)

The statistical squares sampled each month were:—

Table 25. Maturity and racial characters — north-eastern North Sea 1959

	Percentage maturity (All age-groups)								No.	Vert. S. (Actual numbers — All age-groups)							
	Maturity Stage									Vertebrae							
	I	II	III	IV	V	VI	VII	VII-II		54	55	56	57	58	59	Mean	No.
March	1.4	2.1	0.7	4.9	1.4	28.8	12.7	47.8	142	1	4	43	68	23	—	56.77	139
April	17.7	8.8	0.3	0.1	—	10.1	10.9	52.1	797	1	18	321	381	58	3	56.62	782
May	33.5	29.0	—	—	—	—	0.8	36.7	245	—	10	96	115	15	1	56.58	237
June	22.4	58.2	15.3	1.0	—	—	—	3.1	98	—	4	42	40	7	—	56.53	93

Table 26. Age composition of spring and autumn spawners in north-eastern North Sea, between March and June 1959

Year-class	Spring group					Year-class	Autumn group					Total sample			
	Winter-rings	March	April	May	June		Winter-rings	March	April	May	June	Number	%	Spring	Autumn
1957	2	1	26	27	8	1956	2	3	136	83	83	62	305	16.9	83.
1956	3	20	72	1	—	1955	3	7	27	16	3	93	53	63.7	36.
1955	4	28	26	—	—	1954	4	21	181	46	1	54	249	17.8	82.
1954	5	4	15	4	—	1953	5	8	83	11	1	23	103	18.3	81.
1953	6	2	6	1	—	1952	6	20	94	19	—	9	133	6.3	93.
1952	7	3	8	2	—	1951	7	2	36	12	—	13	50	20.6	79.
1951	8	5	8	—	—	1950	8	2	23	5	—	13	30	30.2	69.
1950	9	—	1	—	—	1949	9	4	19	4	—	1	27	3.6	96.
1949	10	—	—	—	—	1948	10	5	8	3	—	—	16	—	100.
1948 and older	>10	—	—	—	—	1947 and older	>10	—	—	—	—	—	31	—	100.
Total		63	162	35	8	Total		76	628	204	89	268	997	21.2	78.

	Aberdeen			Fraserburgh		Peterhead		Lerwick	
April				14B					
May	20C	18C	18E		16D		16D		
		17D	17E	15C	15D	15C	15D		
		16D	16E	14C	14D	14C	14D		
June	20C	19D						20C	20D
	18C	18D		16C		16C	16D		19D
	17C	17D		15C	15D	15C			18D
	16C	16E	15E		14D	14D	13D		
July	19D	18C	18D	16C					
	17C	17D	16D	15C					
	15D	14C	14D	14C	14D	14C	14D		20D
	13E	12E	10C				13D	18C	18D
August	14C	14D	14E	15C		14C	14D		19D
	13C	13D	12C	14C	14D	13C	13D	18C	18D
September	14C	14D		14C	14D		14D		
	13C	13D			13D		13D		

Table 27. Maturity and racial characters — north-western North Sea 1959

A. Percentage Maturity

(All age-groups)
Maturity stage

B. Vert. S.

(Actual numbers — All age-groups)
Number of vertebrae

	I	II	III	IV	V	VI	VII	VII-II	No.	Number of Vertebrae								Mean	No.
Aberdeen										53	54	55	56	57	58	59			
May	31.8	43.0	0.6	—	—	0.1	1.2	23.3	850	—	—	27	332	412	55	2	56.61	828	
June	18.1	56.9	18.0	2.6	0.1	—	0.4	3.8	944	—	—	23	372	464	46	2	56.59	907	
July	9.8	14.3	49.8	20.2	5.4	—	—	0.5	1,046	—	—	32	444	489	51	—	56.55	1,016	
August	2.3	3.4	16.4	43.2	15.1	11.1	5.1	3.5	970	—	1	22	437	449	36	1	56.53	946	
Sept.	8.1	6.8	10.4	8.4	4.4	8.1	3.6	50.2	249	—	—	8	104	126	7	—	56.54	245	
Fraserburgh																			
April	63.0	28.7	—	—	—	1.0	—	7.3	300	—	—	9	131	137	14	2	56.55	293	
May	44.4	43.3	0.8	0.3	—	—	2.3	8.9	968	1	—	20	400	483	40	1	56.57	945	
June	20.1	60.5	14.4	3.8	0.2	0.2	0.1	0.6	990	—	—	20	322	314	25	—	56.51	681	
July	3.6	15.2	45.0	30.1	5.9	—	—	0.1	979	—	—	16	159	194	11	—	56.53	380	
August	1.6	1.0	20.9	37.4	14.8	6.7	14.6	3.0	912	—	—	5	178	207	16	—	56.58	406	
Sept.	1.0	0.5	13.3	13.3	9.7	10.2	30.1	21.9	196	—	—	2	87	96	10	—	56.58	195	
Peterhead																			
May	40.6	50.2	1.1	0.2	—	—	—	7.8	446	—	—	11	182	227	14	—	56.56	434	
June	23.1	58.4	13.4	3.4	0.8	0.1	—	0.8	796	—	1	19	260	291	13	1	56.51	585	
July	6.2	16.3	45.1	26.5	5.8	—	—	0.1	1,095	—	—	30	285	280	36	—	56.51	631	
August	2.8	4.4	25.6	38.0	17.4	7.2	3.0	1.6	887	—	—	10	213	246	14	2	56.56	485	
Sept.	1.0	1.5	14.6	26.1	13.1	11.1	5.1	27.6	199	NO DATA								—	—
Lerwick																			
June	8.2	56.8	18.0	4.4	0.9	0.1	1.7	9.9	1,042	1	—	22	381	545	64	1	56.64	1,014	
July	9.6	13.9	38.6	25.8	11.4	0.2	0.2	0.3	1,133	—	—	22	421	587	70	3	56.65	1,103	
August	1.9	1.6	9.6	22.5	27.0	5.2	26.1	6.1	636	—	—	18	276	303	23	2	56.54	622	

The length and age composition of the samples from the north-western North Sea in 1959 are shown in Figure 12, and the maturity and Vert. S. data are given in Table 27.

The analyses of the otolith characters of the Lerwick and Aberdeen samples are given in Tables 28 to 31. Tables 28 and 29 give the data for May to July and August at Lerwick and Tables 30 and 31 the data from north and south of 59° N in the

Aberdeen samples between May and July, i. e. from the Shetland and Buchan grounds.

These data show that the catches in the north-western North Sea in 1959 were composed principally of 2-ringed fish (year-class 1956—1957) which were responsible for 80% of the total landings. The spring spawning component made a greater contribution to the catches in the northerly areas than in the southerly ones.

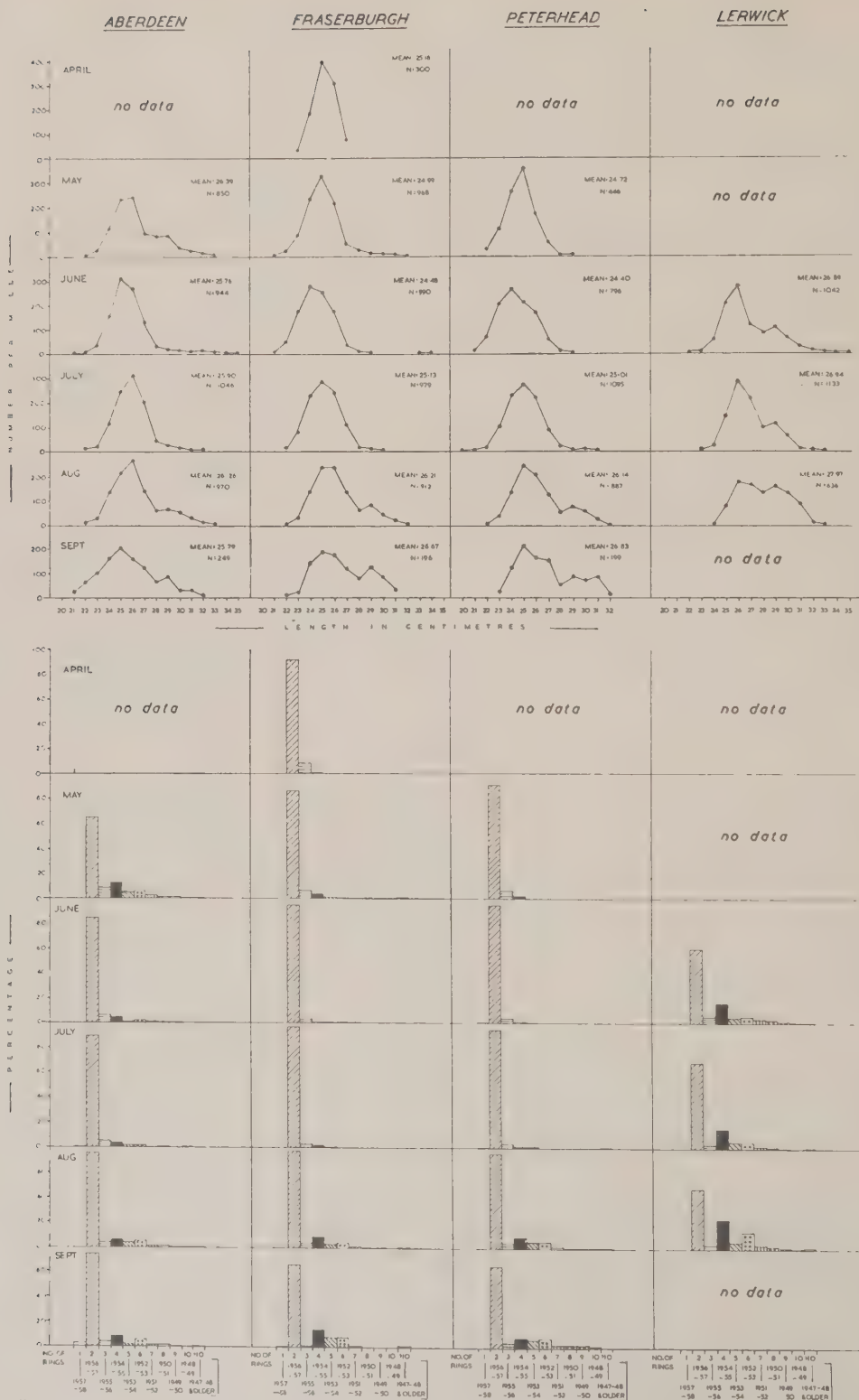


Figure 12. Length and age composition of north-western North Sea drift-net samples April-September 1959. (Length frequencies unsmoothed).

Table 28. Age composition of spring and autumn spawners at Shetland between June and July 1959

Spring group				Autumn group				Total sample			
Year-class	Winter-rings	June	July	Year-class	Winter-rings	June	July	Number		%	
								Spring	Autumn	Spring	Autumn
1957	2	60	133	1956	2	561	632	193	1193	13.9	86.1
1956	3	5	5	1955	3	54	33	10	87	10.3	89.7
1955	4	13	1	1954	4	167	169	14	336	4.0	96.0
1954	5	15	3	1953	5	40	55	18	95	15.9	84.1
1953	6	3	1	1952	6	62	52	4	114	3.4	96.6
1952	7	7	1	1951	7	19	20	8	39	17.0	83.0
1951	8	8	1	1950	8	9	8	9	17	34.6	65.4
1950	9	2	—	1949	9	5	5	2	10	16.7	83.3
1949	10	—	—	1948	10	4	—	—	4	—	100.0
1948 and older	<10	—	—	1947 and older	<10	3	3	—	6	—	100.0
Total		113	145	Total		924	977	258	1901	11.9	88.1

Table 29. Age composition of spring and autumn spawners at Shetland in August 1959

Spring group			Autumn group			Total sample			
Year-class	Winter-rings	August	Year-class	Winter-rings	August	Number		%	
						Spring	Autumn	Spring	Autumn
1957	2	13	1956	2	288	13	288	4.3	95.7
1956	3	—	1955	3	18	—	18	—	100.0
1955	4	1	1954	4	146	1	146	0.7	99.3
1954	5	—	1953	5	35	—	35	—	100.0
1953	6	2	1952	6	77	2	77	2.8	97.2
1952	7	—	1951	7	20	—	20	—	100.0
1951	8	—	1950	8	13	—	13	—	100.0
1950	9	—	1949	9	6	—	6	—	100.0
1949	10	—	1948	10	1	—	1	—	100.0
1948 and older	<10	—	1947 and older	<10	6	—	6	—	100.0
Total		16	Total		610	16	610	2.6	97.4

The lengths of the principal age-groups in the samples at Fraserburgh and Peterhead remained at the same high level as in recent years. The mean lengths (cm) of the 2—5-ringed fish in 1959 and earlier years were as follows:—

Year	Age (winter-rings)			
	2	3	4	5
1950	24.51	24.92	26.05	27.73
1951	24.73	25.76	25.93	26.49
1952	24.86	26.25	26.82	27.26
1953	24.54	26.37	27.00	28.09
1954	24.69	26.92	28.12	28.71
1955	24.18	26.81	28.68	29.34
1956	24.76	26.97	28.36	29.43
1957	24.28	26.16	28.30	29.31
1958	24.51	26.76	28.09	28.97
1959	24.88	26.28	28.25	29.25

Trawled herring

Samples were taken between September and November from Swedish trawlers landing at Aberdeen and these have been grouped according to the statistical squares in each month. The length and age compositions are given in Table 32 and the corresponding maturity and Vert. S. data in Table 33.

These trawl samples were taken from a very wide area in the north-eastern and north-western North Sea. As with the drift-net fisheries, 2-ringed fish were dominant in the catches, but to a lesser degree than on the Buchan grounds.

B. West Coast

The Fisheries

Minch

In 1959 drift-net and ring-net fishing were conducted mainly from the ports of Stornoway, Ullapool, and Gairloch in the North Minch and Mallaig and Oban in the South Minch.

An exceptionally productive winter fishery (January/March) was followed by a very poor summer fishery. However, large shoals of herring were located in the Minch during the autumn and a very productive and successful fishery ensued.

The landing statistics for the North and South Minch areas are given in Table 34.

The total yield from the Minch fisheries in 1959 showed an increase over the previous three years (1956—1958) and the catch per landing in each drift-net and ring-net fishery was higher than in 1957 and 1958.

Table 33. Maturity and racial characters — trawled herring 1959

Percentage maturity (All age-groups)										Vert. S. (Actual number — All age-groups)									
Maturity stage										Number of vertebrae									
		I	II	III	IV	V	VI	VII	VII-II	No.	54	55	56	57	58	59	Mean	No	
Sept.	17F	8.0	16.0	2.0	—	—	—	9.0	65.0	100	—	2	48	42	8	—	56.56	100	
Oct.	20G	10.0	8.0	4.0	2.0	—	—	10.0	66.0	50	—	1	20	27	1	—	56.57	49	
	17F	6.0	1.0	2.0	—	—	—	25.0	66.0	100	—	4	45	44	5	—	56.51	98	
	16E	5.0	2.0	1.0	5.0	—	—	6.0	81.0	100	—	2	39	55	3	—	56.59	99	
	15E	5.0	4.0	2.0	—	—	—	7.0	82.0	100	—	4	44	47	5	—	56.53	100	
	15G	14.0	—	12.0	10.0	2.0	2.0	10.0	50.0	50	—	2	20	20	4	—	56.56	46	
	15K	6.0	2.0	—	—	—	2.0	4.0	86.0	50	—	—	19	28	1	—	56.62	48	
	12F	14.0	6.0	4.0	—	—	—	40.0	36.0	50	—	4	18	25	1	—	56.47	48	
Nov.	20G	34.0	2.0	—	—	—	—	4.0	60.0	50	—	—	17	29	3	—	56.71	49	

Table 34. West coast herring landings, 1956—1959

Year	Landings (crans)	North Minch		Landings (crans)	South Minch	
		Number of arrivals	Landings per arrival (crans)		Number of arrivals	Landings per arrival (crans)
Drift-net						
1956	80,727	4,423	18.3	39,010	971	40.2
1957	114,561	5,285	21.7	11,005	318	34.6
1958	172,006	7,657	22.5	15,907	415	38.3
1959	166,305	6,721	24.7	21,326	447	47.7
Ring-net						
1956	21,762	774	28.1	50,782	1,125	45.2
1957	20,652	881	23.4	43,466	1,563	27.8
1958	13,485	761	17.7	56,549	2,238	25.3
1959	23,908	965	24.8	70,770	2,022	35.0

Table 35. Maturity and racial characters — North Minch

A. Percentage maturity (All age-groups)												
Maturity Stage	Jan.	Feb.	Mar.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
I	3.01	7.33	6.35	27.08	32.39	33.26	31.96	47.99	21.61	9.34	17.31	
II	0.60	1.00	0.33	43.75	48.58	35.71	9.28	6.32	6.53	4.55	2.07	
III	4.01	2.33	0.67	—	3.64	18.97	20.62	2.59	1.01	2.53	3.10	
IV	3.21	3.67	—	—	2.02	8.93	25.77	19.25	0.50	0.76	0.52	
V	1.60	1.33	0.33	—	0.40	1.34	11.34	8.33	0.50	0.25	0.52	
VI	0.40	—	1.34	—	—	—	—	—	2.01	0.25	0.26	
VII	—	—	—	—	—	—	—	2.01	3.52	—	0.52	
VII-II	87.17	84.33	90.97	29.17	12.96	1.79	1.03	13.51	64.32	82.32	75.71	
Number	499	300	299	48	247	448	97	348	199	396	387	

Mean Vert. S. for each maturity stage (All age-groups)

(Numbers of fish examined in brackets)											
I	56.87 (15)	56.90 (20)	56.47 (19)	57.13 (13)	56.73 (79)	56.83 (147)	56.61 (31)	56.87 (166)	56.63 (43)	56.76 (37)	56.80 (65)
II	57.33 (3)	56.67 (3)	56.00 (1)	56.65 (20)	56.65 (115)	56.46 (156)	56.88 (8)	56.71 (21)	56.92 (12)	56.78 (18)	56.71 (7)
III	56.85 (20)	57.14 (7)	56.50 (2)	—	56.44 (9)	56.49 (84)	56.35 (20)	56.67 (9)	56.67 (3)	57.00 (10)	57.00 (10)
IV	57.00 (15)	57.00 (11)	—	—	56.80 (5)	56.53 (38)	56.64 (25)	56.49 (67)	57.00 (1)	57.33 (3)	58.00 (1)
V	57.38 (8)	57.25 (4)	57.00 (1)	—	56.00 (1)	56.83 (6)	56.55 (11)	56.55 (29)	57.00 (1)	57.00 (1)	56.50 (2)
VI	57.50 (2)	—	57.00 (4)	—	—	—	—	—	56.00 (4)	56.00 (1)	57.00 (1)
VII	—	—	—	—	—	—	—	56.71 (7)	56.14 (7)	—	—
VII-II	56.58 (428)	56.53 (252)	56.62 (265)	56.50 (14)	56.69 (32)	57.00 (8)	58.00 (1)	56.61 (46)	56.48 (122)	56.59 (317)	56.54 (242)
Overall mean	56.63 (491)	56.60 (297)	56.62 (292)	56.70 (247)	56.68 (241)	56.61 (439)	56.60 (96)	56.72 (345)	56.52 (193)	56.63 (387)	56.61 (332)

NORTH MINCH 1959

SOUTH MINCH 1959

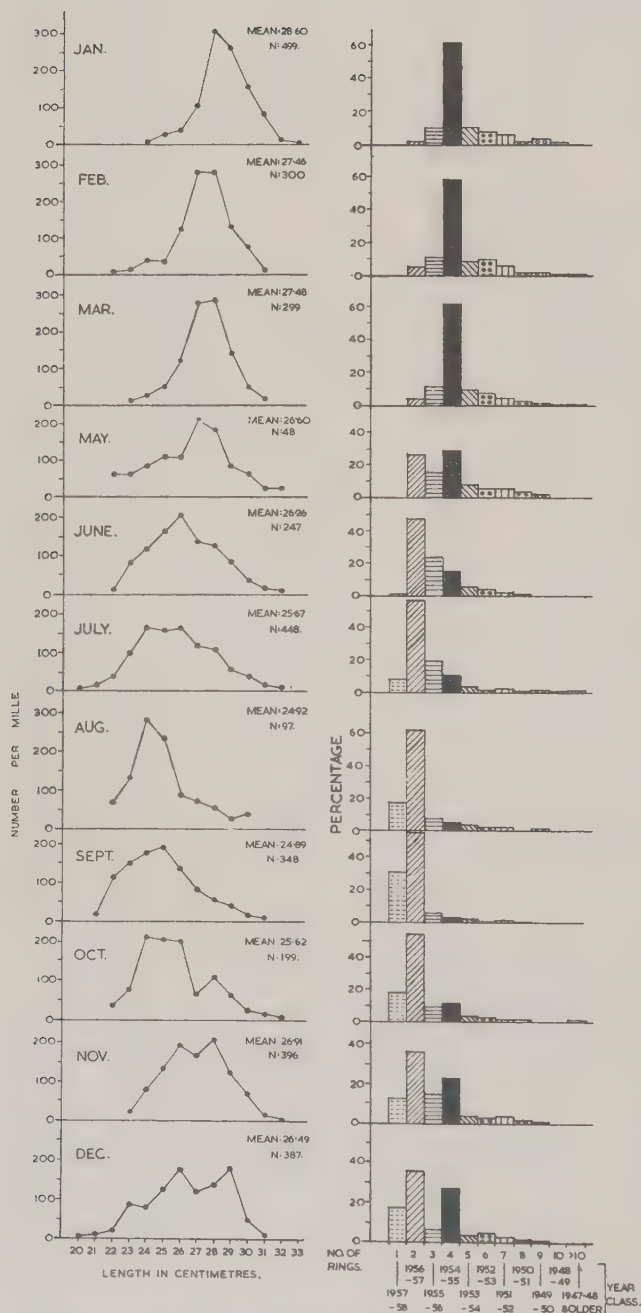


Figure 13. Length and age composition of North Minch drift-net samples January–December 1959. (Length frequencies unsmoothed).

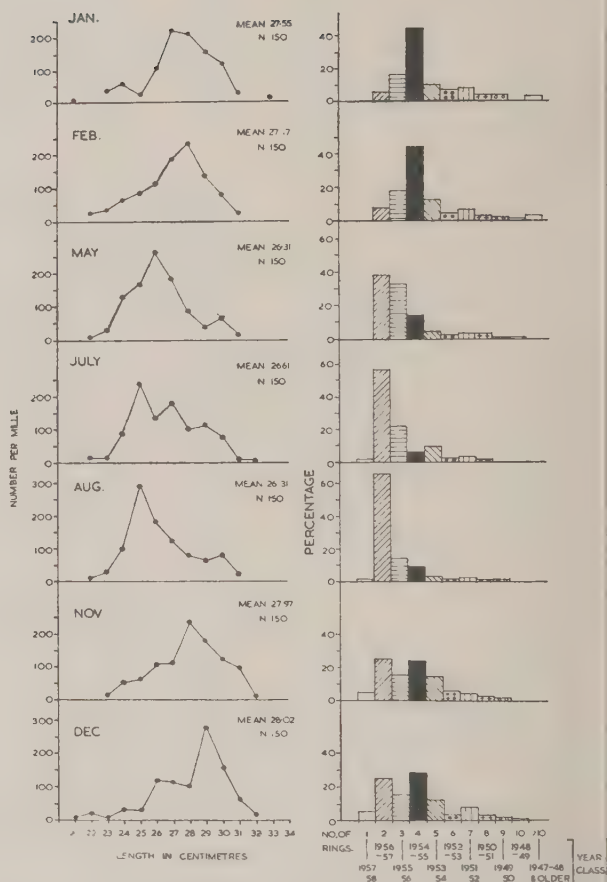


Table 36. Maturity and racial characters — South Minch

A. Percentage maturity (All age-groups)							
Maturity Stage	Jan.	Feb.	May	July	Aug.	Nov.	Dec.
I	8.67	11.33	49.33	30.00	12.67	8.67	12.67
II	1.33	0.67	24.67	59.33	6.67	4.67	1.33
III	3.33	—	—	8.67	36.00	10.67	2.00
IV	—	0.67	—	0.67	35.33	4.67	3.33
V	1.33	—	—	0.67	9.33	5.33	2.00
VI	4.00	—	—	—	—	0.67	1.33
VII	—	—	0.67	—	—	40.67	—
VII-II .	81.33	87.33	25.33	0.67	—	24.67	77.33
Number	150	150	150	150	150	150	150
B. Mean Vert. S. for each maturity stage (All age-groups)							
(Numbers of fish in brackets)							
I	56.55 (11)	56.69 (13)	56.61 (69)	56.84 (45)	56.78 (18)	56.77 (13)	56.58 (19)
II	56.50 (2)	57.00 (1)	56.61 (36)	56.62 (87)	56.80 (10)	57.14 (7)	57.50 (2)
III	56.80 (5)	—	—	56.85 (13)	56.52 (54)	57.06 (16)	56.67 (3)
IV	—	58.00 (1)	—	57.00 (1)	56.47 (53)	56.86 (7)	57.20 (5)
V	57.00 (2)	—	—	57.00 (1)	56.57 (14)	57.00 (8)	57.33 (3)
VI	57.33 (6)	—	—	—	—	57.00 (1)	57.50 (2)
VII	—	—	57.00 (1)	—	—	56.61 (61)	—
VII-II .	56.44 (118)	56.57 (129)	56.50 (36)	56.00 (1)	—	56.47 (36)	56.68 (114)
Overall Mean	56.51 (144)	56.60 (145)	56.58 (142)	56.71 (148)	56.57 (149)	56.70 (149)	56.72 (148)

5 year-old (4-ring) fish of the 1954—1955 year-class. In the summer the new recruits, 3 year-old fish of the 1956—1957 year-class predominated and over 70% of these were autumn spawners. During the late autumn fishery the most important age-groups were 3 and 5 year-olds of the 1956—1957 and 1954—1955 year-classes.

C. Tagging

The only tagging carried out in 1959 was in Isle of Man waters where 3,033 Lea and 200 Scottish combination tags were liberated in August/September. So far, 30 Lea and 2 Scottish tags have been returned, mostly from the tagging area within a few days but 3 have been recaptured on the Irish coast within 3 weeks and one was found on the English west coast 176 days after tagging.

B. B. PARRISH
I. G. BAXTER
G. MCPHERSON
J. D. BUCHAN

Table 37. Percentage of spring and autumn spawners — North Minch

Period	Rings	January–March			May–June			July–September			October–December		
		No.	Spring %	Autumn %	No.	Spring %	Autumn %	No.	Spring %	Autumn %	No.	Spring %	Autumn %
1957–58	1	—	—	—	1	100	0	152	78.3	21.7	148	35.8	64.2
1956–57	2	31	93.5	6.5	124	37.1	62.9	512	27.5	72.5	398	10.3	89.7
1955–56	3	67	53.7	46.3	72	25.0	75.0	106	12.3	87.7	101	5.9	94.1
1954–55	4	662	3.8	96.2	56	8.9	91.1	62	4.8	95.2	221	0.9	99.1
1953–54	>4	292	4.5	95.5	43	16.3	83.7	61	6.6	93.4	114	1.8	98.2
Total		1,052	9.8	90.2	296	26.0	74.0	893	31.4	68.6	982	10.6	89.4

Table 38. Percentage of spring and autumn spawners — South Minch

Period	Rings	January–February			May			July–August			November–December		
		No.	Spring %	Autumn %	No.	Spring %	Autumn %	No.	Spring %	Autumn %	No.	Spring %	Autumn %
1957–58	1	—	—	—	—	—	—	2	100.0	0	17	41.2	58.8
1956–57	2	20	70.0	30.0	58	37.9	62.1	186	22.6	77.4	75	27.6	72.4
1955–56	3	53	17.0	83.0	50	2.0	98.0	55	21.8	78.2	36	21.6	78.4
1954–55	4	131	0.8	99.2	22	0	100.0	23	4.3	95.7	77	2.5	97.5
1953–54	>4	94	5.3	94.7	20	0	100.0	33	3.0	97.0	87	23.3	76.7
Total		298	9.7	90.3	150	15.3	84.7	299	19.4	80.6	292	19.7	80.3

Survey of the German Commercial Herring Fisheries in 1959 and the Biological Conditions of the Stock

(Charts 13-35; Tables 39-46)

A. The Fisheries

The total landings from the German fishing fleet in 1959 are given in Table 39. The total catch increased by 8.3% (20,000 tons). 81.9% (213,000 tons) consisted of herring for human consumption, and 18.1% (47,000 tons) of factory herring. The rise of the landings is mainly due to the larger catches of the trawlers in the North Sea and in the Channel (9.2% = 11,000 tons) and to the larger catches of the deep-sea cutters for factory herring (46.9% = 15,000 tons).

1. Herring trawlers

The catch of the trawlers increased in the North Sea (14.7% = 14,000 tons) and in the Channel (71.4% = 5,000 tons). The number of trips fell off from 1,401 in 1958 to 1,377 in 1959. While in the North Sea the trips, 1,082, remained the same they increased in the Channel from 107 to 131 and declined in the areas around Ireland from 212 to 154. The catch per day's fishing increased in the North Sea from 9.6 to 11.7 tons, in the Channel from 8.0 to 11.0 tons, while around Ireland a decrease from 11.8 to 8.1 tons took place.

(a) The *spring fishery* in the North Sea was centred on the "Ostkante" (Viking Bank to Utsira) from January to June. The total landings dropped from 20,376 to 8,525 tons. 218 trips were made as compared with 245 in 1958. The catch per day's fishing declined from 8.7 to 4.0 tons. The reduced yield was conditioned by a lower density of late winter spawners.

25 trips with a catch of 465 tons herring were made from January to March in the Fladen area, and three trips with 1 ton of herring to the Shetland area.

(b) The *summer/autumn fishery* started on the Fladen Ground area about 1. July and was carried on for 96 days. The main fishing was from 1. July to 21. September. In October some trawlers were fishing once more in this area. 607 trips (+8.3%), as against 560 in 1958 were made in this season. The landings increased from 48,646 to 74,921 tons (54%), and the catch per day's fishing from 9.7 to 15.3 tons (+57.7%). The increased yield was mainly affected by the appearance of a strong new year-class.

The Gut fishery was again of small importance in this year. Only 19 trips against 8 were made from the middle of August to the end of September. The total yield rose from 476 to 1,247 tons and the catch per day from 8.3 to 9.7 tons as the result of increased effort and a denser stock.

On the Dogger Bank grounds, fishing started at the beginning of the second decade of August in the Farn Deep area. On the edge of the Dogger, the fishery commenced at the end of August and lasted until the end of September. The number of trips declined (31.2%) from 215 to 148 tons, but the total yield showed only a small decline from 22,697 to 20,783 tons. The catch per day's fishing increased from 12.2 to 18.0 tons. In spite of the smaller effort, nearly the same yield was caught on account of a higher catch per day, due to the strong 1956 year-class.

The total yield of the trawler fleet on the customary fishing grounds in the North Sea in the summer/autumn fishery increased by 35% from 71,819 to 96,951 tons.

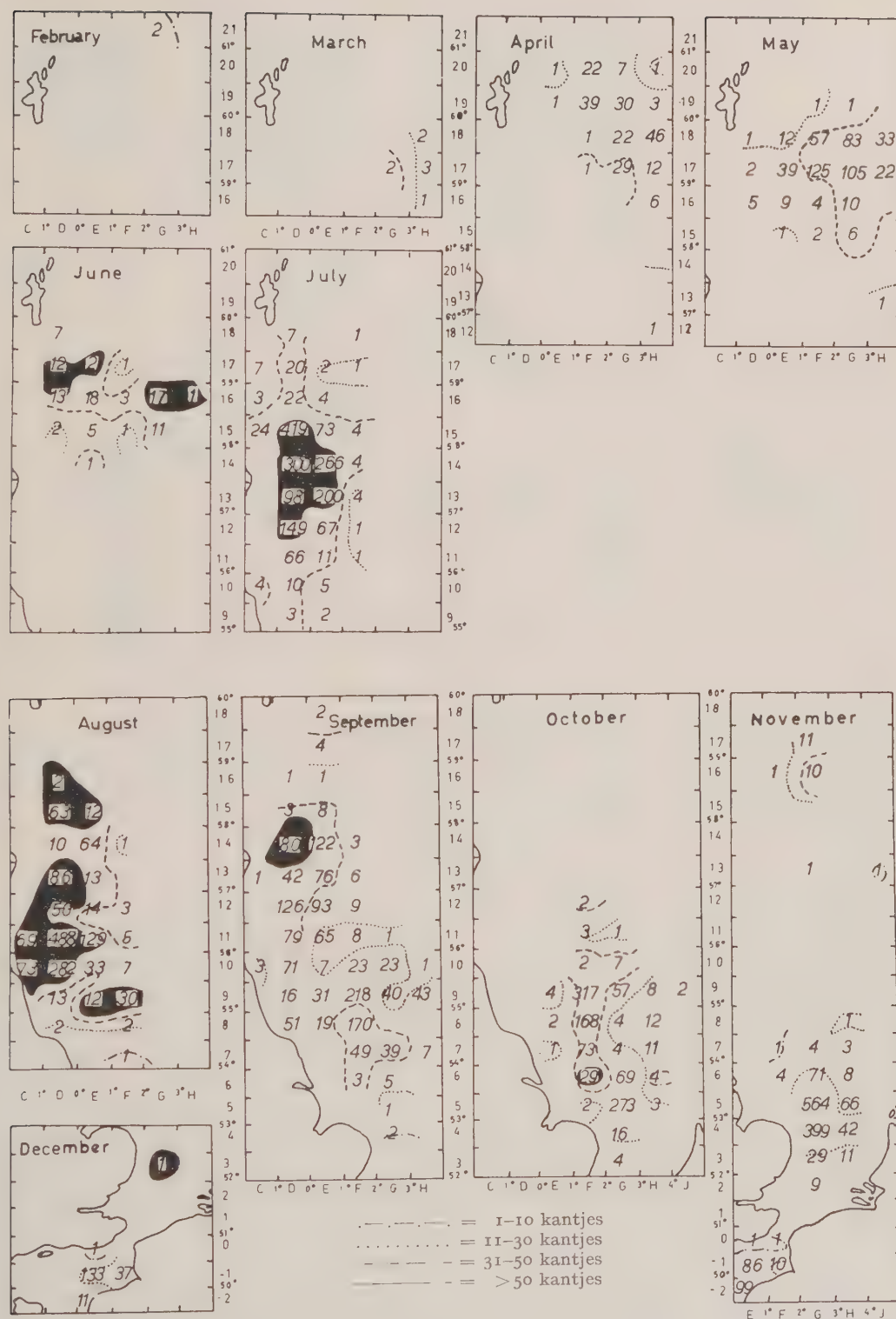
(c) In the *Channel fishery*, in November/December, 131 trips were made as against 107 in 1958. The total yield rose from 6,791 to 12,681 tons (+86.7%), and the catch per day's fishing from 8.0 to 11.0 tons.

The main catch in November came from the Sandettié area. 58 trips were made and 5,383 tons

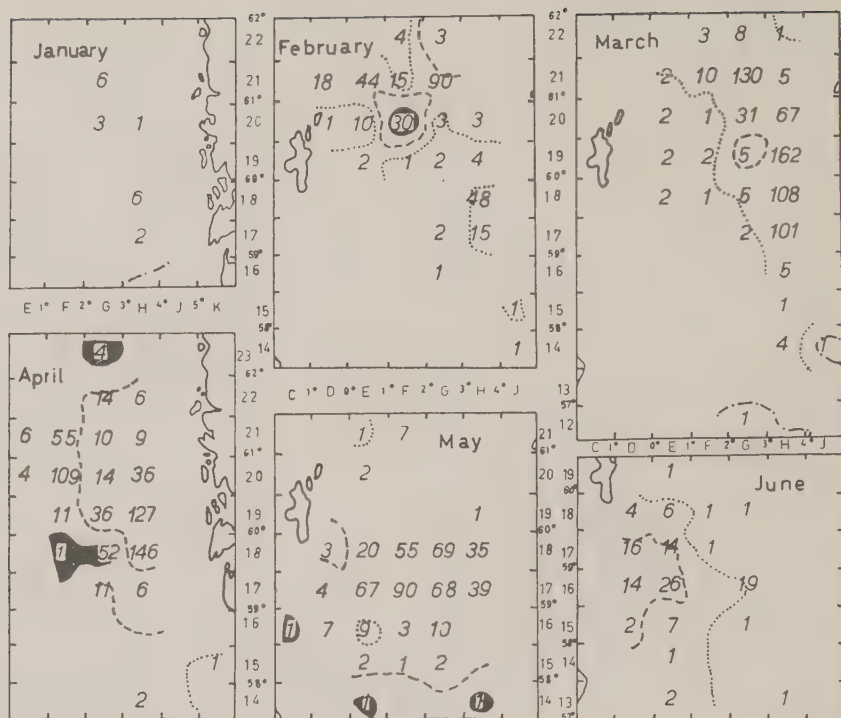
Table 39. Total herring landings (in 1,000 tons) of the German fishing fleet in 1959

	North Sea	Channel	SE Ireland	N Ireland	Other areas	Total
Trawlers	109 (95)	12 (7)	8 (10)	2 (8)	+ (+)	131 (120)
Drifters	67 (67)	3 (3)	+ (+)	— (—)	— (—)	70 (70)
Fresh herring	8 (10)	— (—)	— (—)	— (—)	— (—)	8 (10)
Drift-net	3 (3)	— (—)	— (—)	— (—)	— (—)	3 (3)
Trawl	5 (7)	— (—)	— (—)	— (—)	— (—)	5 (7)
Salt herring	59 (57)	3 (3)	+ (+)	— (—)	— (—)	62 (60)
Drift-net	39 (45)	1 (3)	+ (+)	— (—)	— (—)	40 (48)
Trawl	20 (12)	2 (+)	+ (+)	— (—)	— (—)	22 (12)
Deep-sea cutters	45 (32)	— (—)	— (—)	— (—)	14 (18)	59 (50)
for consumption	1 (2)	— (—)	— (—)	— (—)	11*) (16)	12 (18)
for factories	44 (30)	— (—)	— (—)	— (—)	3*) (2)	47 (32)
Total	221 (194)	15 (10)	8 (10)	2 (8)	14 (18)	260 (240)

() = 1958; *) = Baltic/Kattegat/Skagerrak.



Charts 13-23. German lugger herring fishery. Drift-net. Mean catch per fishing day and number of hauls.



Charts 24-29.

were caught (against 4,655 tons in 1958). The catch per day was 10.1 tons, against 13.4 tons. In December only, a fishing took place in the Dieppe area. 73 trips (against 23) were made. The total yield increased from 723 to 7,298 tons and the catch per day from 2.8 to 9.8 tons. Increased effort and a new year-class were mainly responsible for the higher yield.

(d) From January to March and from October to December 1959 the trawlers were fishing in the Dunmore area. 115 trips yielded 7,771 tons, as against 97 trips with 10,387 tons in 1958. The bulk of the catch was taken in the first three months of the year. The total catch per day dropped from 12.3 to 9.1 tons; it declined in the early months, but showed an improvement in the last months of the year.

In August, October, and November 39 trips were made to the north of Ireland (Klondyke to Stanton Bank). The total yield in this area was 2,324 tons. The main catch was made in November. The catch per day decreased from 10.9 to 8.6 tons.

Some fishing also took place in August in the North Minch area.

(e) As in earlier years trawlers fished from October to December in the "Ostkante" area. 2,754 tons were caught in 61 trips. The catch per day decreased from 6.8 to 6.0 tons.

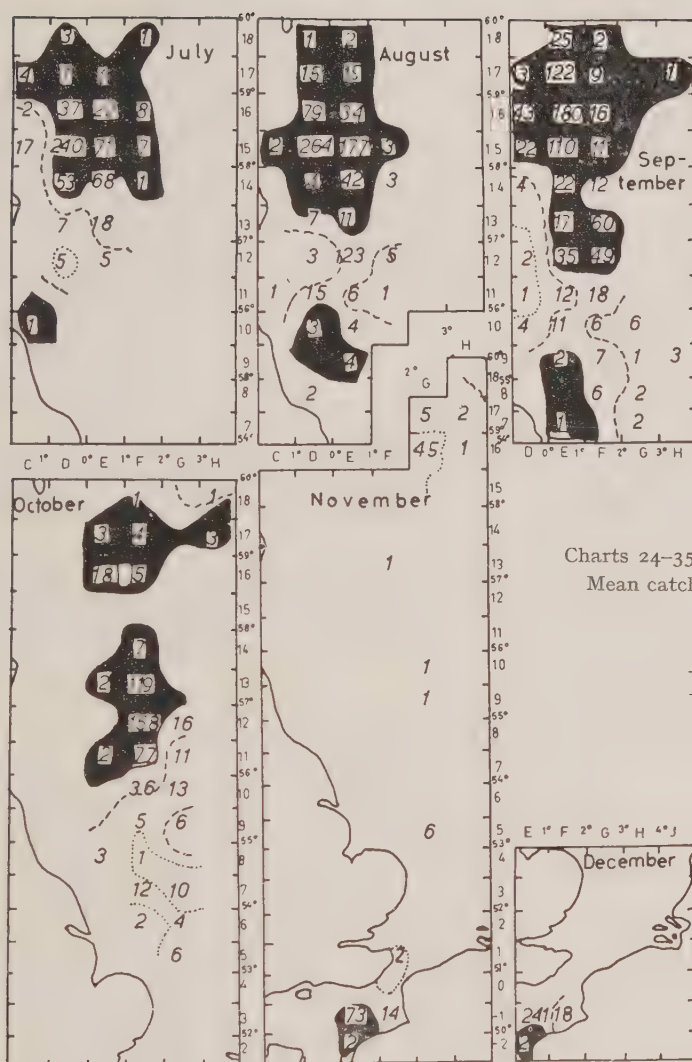
2. Drifters

The total yield of 70,338 tons was nearly the same as in 1958 (69,980 tons). 42,240 tons were caught with the drift-net, 28,098 tons with the trawl. The catch in the North Sea amounted to 66,752 tons, in the Channel 2,794 tons, and at Dunmore 792 tons.

(a) The *fresh herring season* from February to June yielded 8,086 tons from 249 trips as against 9,788 tons from 226 trips in 1958; 35% of the yield was caught by drift-net and 65% by trawl. The catch per day for the drift-net was 1.8–4.4 tons, and for the trawl 4.1–6.0 tons. Charts 13–35 show the monthly distribution of the mean catch and the number of hauls for the drift-net (Charts 13–23) and the trawl (Charts 24–35) for 1959.

(b) From the North Sea, 58,666 tons of *salted herring* were landed from May to December in 612 trips as against 56,635 tons in 1958; 36.3% of these were caught by trawl. The catch per day increased from 3.7 to 4.3 tons (drift-net) and from 4.9 to 6.4 tons (trawl).

In the Fladen area the catch rose from 7,589 to 34,816 tons (+ 358.8%). The catch per day showed an increase from 2.9 to 4.6 tons (drift-net) and from 4.3 to 8.3 tons (trawl) as the result of the appearance of the strong new 1956 year-class.



On the Gut grounds the yield of 15,116 tons was nearly the same as in 1958. The number of fishing days decreased from 3,688 to 2,854. However, the catch per day increased from 4.3 to 5.2 tons (drift-net) and from 4.3 to 5.7 tons (trawl). The main catch (72.3%) was made by the drift-net (10,934 tons).

In the Dogger Bank area the yield decreased from 22,333 tons to 8,256 tons and the catch per day from 3.9 tons to 3.5 tons (drift-net) and from 4.0 to 3.0 tons (trawl). The main fishing was with the drift-net (94.3%). The reduced yield was the result of diminished effort due to good fishing in other areas.

In the Southern Bight ("Binnensee") the yield dropped from 9,762 tons to 3,607 tons. The catch per day decreased from 3.2 tons to 2.1 tons (drift-net).

(c) The Channel fishery showed a decrease in the number of fishing days from 1,513 to 907 (40.1%), and the total yield declined from 3,071 to 2,794 tons. The drift-net catches, perhaps hampered through the weather conditions, decreased from 2,760 to 641 tons, whereas the trawl catches increased from 311 tons to 2,153 tons. The catch per day by drift-net declined from 2.3 tons to 1.3 tons while the trawl increased from 1.5 to 4.9 tons.

(d) From the Dunmore area 588 tons herring were landed at the beginning of February. 237 tons were caught with the drift-net, 337 tons by trawl. The catch per day was 4.1 tons (drift-net) and 3.1 tons (trawl). In November and December 214 tons were caught in this area, 73 tons by drift-net and 141 tons by trawl. The catch per day was 2.7-1.2 tons (drift-net) and 0.1-3.6 tons (trawl).

3. Cutters

The total yield of herring for human consumption from the deep-sea and coastal cutters in the North Sea decreased from 1,964 tons to 533 tons. The deep-sea cutters made only 8 trips as against 11 trips in 1958. The total output fell from 94.3 tons to 92.2 tons.

The total catch of "oil" herring from different types of fishery of the deep-sea cutters in the North Sea increased from 29,594 tons to 44,314 tons. The main catch came from the "oil" herring fishery which rose from 25,835 tons to 40,755 tons.

Biological Data

1. Viking Bank/Utsira ("Ostkante")

Twenty-one samples, totalling 15,120 herring were examined from February to November. The average length of the herring in the different months (Table 40) declined from 32.78 cm to 25.80 cm (February—June) and increased after that until November (27.66 cm). Table 41 shows that in February the maturity stages I/II and V/VI

were the most frequent, whereas in March the sequence of stages was V/VI, I/II, and VII/II. In May stages II/I and VII/II predominated. In July stages II/I were most abundant followed by III/IV. In October all maturity stages were present, the II/I, V/IV, and VII/II stages being the most frequent.

The age composition of the catches (Table 42) indicates that in February the III, V, VII, and X and older age-groups were the most abundant. In March a similar age composition was found. In May, however, the 3, 5, and 6 year-olds formed the bulk of the catch. In July and October the 3 year-old fish were predominant in both months and a remarkable number of 2 year-old herring appeared in the catches.

The total vertebral count data (V.S.) are given in Table 43. These show values of 56.76 and 56.81 in February and March and a decrease to 56.54 in October.

The average number of vertebrae (V.S.), the average number of keeled scales (K_2), and the average number of gill rakers in relation to maturity stages are given in Tables 44, 45, and 46. These

Table 40. Length composition of all samples (‰)

Gear Area Samples Month	T II	T II	D II	T III	T III	D III	T IV	T V	T VII	T X	T XI	T VI	T VII
cm 39	—	—	—	—	1	—	—	—	—	—	—	—	—
38	—	3	—	—	4	—	—	—	—	—	—	—	—
37	—	9	3	19	23	3	—	—	—	—	—	—	—
36	—	18	3	36	37	9	—	—	—	—	—	—	—
35	—	16	7	71	23	13	1	—	—	—	—	—	—
34	—	14	38	81	27	34	—	—	—	—	—	—	2
33	6	24	88	113	45	58	9	1	9	2	1	—	—
32	40	37	221	163	90	110	18	4	22	2	2	—	3
31	83	71	235	232	122	124	47	10	73	3	20	4	6
30	156	114	238	178	167	181	83	41	81	26	106	17	18
29	156	145	91	69	134	205	125	80	80	59	138	26	11
28	133	132	45	32	105	198	201	110	63	56	169	56	23
27	85	105	31	6	58	56	219	95	39	96	122	81	77
26	49	52	—	—	24	9	96	100	63	224	98	133	194
25	23	32	—	—	38	—	73	140	99	313	102	268	286
24	76	68	—	—	49	—	60	135	125	115	107	269	242
23	104	91	—	—	34	—	51	138	134	41	105	125	100
22	60	50	—	—	14	—	15	114	71	39	22	21	26
21	23	15	—	—	4	—	2	25	24	6	7	—	3
20	6	3	—	—	1	—	—	7	25	10	—	—	3
19	—	1	—	—	—	—	—	—	55	8	1	—	3
18	—	+	—	—	—	—	—	—	29	—	—	—	3
17	—	—	—	—	—	—	—	—	8	—	—	—	—
16	—	—	—	—	—	—	—	—	—	—	—	—	—
15	—	+	—	—	—	—	—	—	—	—	—	—	—
14	—	+	—	—	—	—	—	—	—	—	—	—	—
Total	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number	527	6458	286	467	1701	1114	851	1300	890	611	915	851	613
Av. length cm	28.26	28.33	31.36	32.78	30.10	30.49	28.33	26.36	25.80	26.66	27.66	25.60	25.54
Males ‰	470	380	640	—	442	—	—	485	386	450	—	477	422

T = Trawl, D = Driftnet, PT = Pelagic Trawl, M = Market, S = Sea.

indicate that in February and March in this area two groups of herring were present. Stages III to VII were composed of late winter spawners, and stages II and VII/II of North Sea autumn spawners. Stage I was a mixture of both groups. In May the proportion of late winter spawners had diminished and the autumn spawners were predominant; only stage I contained some winter spawners. July presented a similar composition, except that winter spawners were also present in maturity stage II. In October only autumn spawners were present in the fishing area.

2. Bressay/Fladen Ground

Twenty-two samples containing 9,276 herring were investigated from this area. A change of about 2.5 cm was observed in the average length. From June to November, with the exception of October (28.3 cm), the average lengths were between 24.3 and 25.9 cm (Table 40). The maturity (Table 41) was advancing from June to September. In June stages II/III predominated, whereas in July stages III/IV were the most frequent. In

August IV/V were the abundant stages, and in September VII/II, II, VII, and I. In November stage II predominated.

The age composition (Table 42) shows the predominance of a new strong 3 year-old (1956) year-class (301—945‰) from June to September. In addition, in August the year-classes 1952 (222‰), 1953, and 1954 were of some importance. In November 5 year-old herring were also more abundant.

The average number of vertebrae found was 56.50—56.59 (Table 43).

The different meristic characters in relation to maturity stages (Tables 44—46) show, that in all months except November, autumn spawners were predominant. Only maturity stages I and II were a mixture of autumn and late winter spawners. It is remarkable that in July in the Bressay area there was a group of autumn spawners in maturity stages III/IV with low keeled scale and high gill raker counts but a normal number of vertebrae. In November only autumn spawners were in the catches.

Table 40 (continued)

Gear Area	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
			Fladen Ground					North Minch	Gut			Dogger Bank			
Samples Month	M VII	S VII	M VIII	M IX	S IX	M X	M IX	M VIII	S VII	S X	S VII	M IX	S IX	M X	S X
cm 36 ...	—	+	—	—	—	—	—	—	I	—	—	—	—	—	—
35 ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
34 ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
33 ...	—	I	—	+	—	—	—	—	—	—	—	—	—	—	—
32 ...	—	—	I	I	—	6	—	—	I	—	—	—	—	4	I
31 ...	—	7	9	8	—	22	2	7	3	7	—	I	10	27	5
30 ...	—	30	13	26	—	139	16	40	7	25	—	20	5	79	12
29 ...	—	36	66	53	10	225	29	83	18	31	—	26	50	91	16
28 ...	3	42	82	65	30	254	28	165	24	35	—	50	30	84	17
27 ...	8	94	86	103	40	98	55	170	48	42	5	51	55	62	27
26 ...	74	205	150	174	40	108	79	208	109	79	17	82	45	93	40
25 ...	205	256	231	247	230	98	214	123	118	147	48	126	65	73	53
24 ...	296	190	139	145	300	35	279	87	144	198	85	187	170	74	100
23 ...	285	114	111	91	210	6	191	47	127	233	155	220	180	139	200
22 ...	107	23	56	50	120	3	68	31	119	120	151	192	175	186	201
21 ...	18	2	9	24	20	3	24	25	76	57	129	44	105	79	124
20 ...	4	+	14	9	—	3	13	7	74	16	106	I	55	9	110
19 ...	—	—	12	3	—	—	2	7	72	9	120	—	25	—	63
18 ...	—	—	10	I	—	—	—	—	38	I	139	—	30	—	20
17 ...	—	—	5	+	—	—	—	—	9	—	43	—	—	—	8
16 ...	—	—	—	—	—	—	—	—	I	—	2	—	—	—	2
15 ...	—	—	—	—	—	—	—	—	I	—	—	—	—	—	+
14 ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	I
13 ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+
Total ...	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number .	707	1515	1765	2749	100	316	750	424	1211	1067	1148	1026	200	922	9326
Av. length															
cm	24.32	25.87	25.66	25.84	24.59	28.25	24.94	26.66	22.86	24.66	21.59	24.66	23.92	25.65	23.04
Males ‰	545	496	550	500	546	—	420	510	477	422	260	510	404	490	446

3. North Minch

Only one sample with 424 herring was examined in August. The average length (Table 40) was 26.66 cm. Maturity stages V/IV and I were predominant (Table 41). The 5 year-old herring (310⁰/₀₀) was the most abundant age-group, followed by the 3 (290⁰/₀₀), 4 (160⁰/₀₀), and 6 year-old herring (Table 42).

The average number of vertebrae was 56.64 (Table 43). According to the different meristic characters (Tables 44—46) the herring at stages I and II were late winter spawners, stages IV and V autumn spawners, and stage III a mixture of both.

4. Gut

Seven samples comprising 2,278 herring were investigated in July and October. The average length was 22.86 cm in July and 24.27 cm in October (Table 40). In July maturity stages I, III, IV, and II were the most frequent, whereas in October stages II, I, and VII/II were abundant (Table 41). Three year-old herring formed the bulk of the

catches in July (668⁰/₀₀) and October (674⁰/₀₀). In July 2 and 4 year-olds were also of importance, and in October only the 2 year-olds (Table 42).

The average number of vertebrae was 56.49 to 56.58 (Table 43). The meristic characters in relation to maturity stages show that in June and October the herring in this area were autumn spawners (Tables 44—46).

5. Dogger Bank area

From this area 41 samples, containing 12,622 fish were investigated in July, September, and October. The average length was 21.59 to 25.65 cm (Table 40). In July, maturity stages I (728⁰/₀₀) and II (130⁰/₀₀) were predominant. In September, stages VI (324⁰/₀₀), VII (173⁰/₀₀), I (153⁰/₀₀), and V (112⁰/₀₀) were abundant, whereas in October, stages I (324⁰/₀₀), V (164⁰/₀₀), IV (140⁰/₀₀), VII/II (129⁰/₀₀), and II (112⁰/₀₀) were most frequent (Table 41). Two year-old fish (590⁰/₀₀) were predominant in July, followed by 3 year-olds (400⁰/₀₀). In September and October 3 year-olds (691⁰/₀₀ and 491⁰/₀₀)

Table 40 (continued)

Gear Area	T PT PT SW-of Egersund			T PT Skagerak		T T Sandettié		T D Channel		T	T T T East of Dogger		
Samples Month	S VII	S XI	S XII	S II	S XI	M XI	M XII	S I	S XI	M XII	S I	S VI	S X
cm 33	—	3	—	—	—	—	—	—	—	—	—	—	—
32	6	10	3	—	1	—	—	—	—	—	—	—	—
31	29	20	31	6	3	—	—	—	—	—	—	—	1
30	59	39	57	14	3	—	—	5	—	2	—	—	—
29	80	66	106	14	2	2	—	12	—	8	—	—	1
28	19	92	134	9	2	8	4	45	46	15	—	—	5
27	15	98	94	7	10	21	9	59	65	29	—	—	5
26	19	168	126	13	33	50	15	162	74	34	—	—	5
25	26	260	164	27	53	99	30	277	157	40	—	—	9
24	96	160	145	98	73	83	116	206	185	78	—	—	41
23	206	61	75	169	182	226	325	143	325	274	—	1	47
22	192	14	41	121	276	312	361	77	120	355	2	1	73
21	100	3	21	92	183	154	124	7	19	138	5	2	75
20	35	1	—	111	100	41	16	—	9	25	5	2	121
19	44	1	—	156	43	4	—	2	—	2	10	11	213
18	57	—	—	91	17	—	—	2	—	—	13	109	100
17	13	—	—	24	11	—	—	—	—	—	10	326	112
16	2	1	—	6	5	—	—	—	—	—	82	312	126
15	2	1	—	9	1	—	—	3	—	—	314	196	60
14	—	1	—	10	1	—	—	—	—	—	335	40	4
13	—	—	—	3	—	—	—	—	—	—	198	—	2
12	—	1	—	2	—	—	—	—	—	—	21	—	—
11	—	—	—	1	—	—	—	—	—	—	5	—	—
10	—	—	—	1	—	—	—	—	—	—	—	—	—
9	—	—	—	4	—	—	—	—	—	—	—	—	—
8	—	—	—	9	—	—	—	—	—	—	—	—	—
7	—	—	—	2	—	—	—	—	—	—	—	—	—
6	—	—	—	1	—	—	—	—	—	—	—	—	—
Total	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number	454	3076	651	1582	1875	707	602	574	108	1780	389	952	702
Av. length cm	23.98	26.45	26.67	21.61	22.58	23.31	23.12	25.18	24.53	23.30	14.94	16.83	19.63
Males %	428	520	580	—	460	530	—	528	—	550	—	—	415

respectively) and 2 year-olds ($119^{0/00}$ and $298^{0/00}$) were the most abundant age-groups (Table 42).

The average number of vertebrae was 56.44 to 56.53 (Table 43). Autumn spawners, of the Bank herring type, probably comprised the maturity stages II—IV in July, while stage I was a mixture of the Bank and Downs groups. In September and October stage I was also a mixture of both, whereas III and IV belonged to the Downs group and V to VII/II to the Bank group (Tables 44—46).

6. SW of Egersund, Skagerak

Thirteen samples, with 7,638 herring were investigated. In the Egersund area the average length was 23.98 cm in July, 26.45 cm in November, and 26.67 cm in December. In the Skagerak the average length was 21.61 cm in February and 22.58 cm in November (Table 40). In July the maturity stages I ($387^{0/00}$), III ($228^{0/00}$), IV ($193^{0/00}$), and II ($156^{0/00}$) were predominant. In November

and December stages II ($786^{0/00}$ and $680^{0/00}$ respectively) were the most frequent (Table 41). In the Egersund area herring from 2 to 10 years of age and older were present in all months, but 3 year-old herring ($508—751^{0/00}$) predominated. In the Skagerak the most abundant year-classes in November were the 2 ($810^{0/00}$) and 3 year-olds ($175^{0/00}$) (Table 42).

The average number of vertebrae were, SW of Egersund 56.50, 56.59, and 56.70, and in the Skagerak in November 56.70 (Table 43). In July autumn spawners were found in the Egersund area whereas in November and December the fish in stages I, II, and VII/II were autumn spawners, and those in stages III to V were late winter spawners (Tables 44—46).

7. Young herring east of Dogger Bank

In January, June, and October six samples, containing 2,043 fish were investigated. The average

Table 40 (continued)

Gear Area Samples Month	T M II	T M III	T German M VI	T Bight M X	T M XI	T M XII	T M I	T South S I	T Ireland S XII	D S XII	T North M X	T Ireland M XI
cm 34	—	—	—	—	—	—	—	—	—	—	5	—
33	—	—	—	—	—	—	—	—	—	—	43	57
32	—	—	—	—	—	—	3	1	—	—	161	142
31	—	—	—	—	—	—	8	7	—	5	217	243
30	—	—	—	—	—	—	35	75	184	44	251	288
29	—	—	—	—	—	—	155	233	334	119	170	126
28	—	—	—	—	—	—	278	233	238	222	109	74
27	—	—	—	—	—	—	246	211	61	178	30	46
26	—	—	—	—	—	—	187	141	122	145	11	16
25	—	—	—	—	—	—	66	72	34	111	1	5
24	—	—	—	—	—	—	16	9	27	96	1	3
23	—	—	—	—	—	—	3	9	—	70	1	—
22	—	—	—	—	—	—	3	6	—	10	—	—
21	—	—	—	—	—	1	—	—	—	—	—	—
20	—	—	—	—	—	2	—	3	—	—	—	—
19	—	—	—	—	1	1	—	—	—	—	—	—
18	—	—	—	—	1	2	—	—	—	—	—	—
17	—	—	—	—	3	6	—	—	—	—	—	—
16	—	—	174	—	9	15	—	—	—	—	—	—
15	—	—	685	—	13	25	—	—	—	—	—	—
14	20	6	141	—	34	26	—	—	—	—	—	—
13	110	104	—	—	38	19	—	—	—	—	—	—
12	310	322	—	4	58	35	—	—	—	—	—	—
11	300	315	—	12	301	302	—	—	—	—	—	—
10	260	193	—	156	433	445	—	—	—	—	—	—
9	—	54	—	739	105	119	—	—	—	—	—	—
8	—	3	—	85	2	2	—	—	—	—	—	—
7	—	3	—	4	1	—	—	—	—	—	—	—
6	—	—	—	—	1	—	—	—	—	—	—	—
Total	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number	100	336	149	1253	1517	4355	374	682	294	387	541	366
Av. length cm	11.83	11.73	15.53	9.60	11.32	11.21	27.84	28.06	28.68	27.13	30.63	30.68
Males $^{0/00}$	—	—	—	—	—	—	580	475	—	601	490	540

Table 41. Sexual maturity in all samples (‰)

Area	Viking Bank/Utsira					Bressay Shoal		Fladen Ground				North- Minch
Month	II	III	V	VII	X	VI	VII	VII	VIII	IX	XI	VIII
Stages I	234	151	175	255	210	123	37	79	100	123	100	180
II	379	126	545	345	270	424	63	150	25	278	810	90
III	10	—	95	224	50	330	400	393	55	3	20	120
IV	36	10	10	169	100	117	422	324	240	10	—	290
V	144	171	—	7	130	6	74	54	520	73	—	320
VI	162	311	—	—	10	—	4	—	—	—	—	—
VII	6	65	—	—	50	—	—	—	50	155	—	—
VII/II	29	166	175	—	180	—	—	—	10	358	70	—
Total	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number	694	199	200	451	100	300	270	593	200	302	100	100

Area	Gut		Dogger Bank			SW of Egersund			Skagerak	Sandettié	Channel Dieppe	
Month	VII	X	VII	IX	X	VII	XI	XII	XI	XI	I	XII
Stages I	330	248	728	153	324	387	121	50	895	—	28	5
II	170	420	130	20	112	156	786	680	85	—	28	—
III	290	67	97	86	50	228	47	10	5	—	—	—
IV	173	45	47	76	140	193	10	80	5	—	—	—
V	37	29	—	112	164	38	2	30	—	100	19	25
VI	—	5	—	324	25	—	—	50	—	900	9	970
VII	—	26	—	173	56	—	36	100	—	—	151	—
VII/II	—	160	—	56	129	—	—	—	10	—	765	—
Total	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number	300	419	300	198	3063	311	591	100	200	100	106	200

Area	East of Dogger			German Bight						South Ireland		North Ireland	
Month	I	VI	X	II	III	VI	X	XI	XII	I	XII	X	XI
Stages I	1000	1000	655	1000	1000	1000	1000	1000	1000	3	—	10	—
II	—	—	47	—	—	—	—	—	—	—	—	180	210
III	—	—	53	—	—	—	—	—	—	—	—	120	110
IV	—	—	70	—	—	—	—	—	—	—	21	590	610
V	—	—	78	—	—	—	—	—	—	6	287	—	—
VI	—	—	23	—	—	—	—	—	—	740	591	—	—
VII	—	—	62	—	—	—	—	—	—	243	96	30	—
VII/II	—	—	12	—	—	—	—	—	—	8	5	70	70
Total	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number	99	200	258	100	100	100	99	200	265	354	188	100	100

lengths were 14.94 cm, 16.83 cm, and 19.63 cm (Table 40). Maturity stage I predominated in January and June (1,000‰); in October this stage was the most frequent (655‰), but also all other stages (II—VII/II) were present (Table 41). In January and June the 1957 year-class was predominant (949‰) whereas in October 2 (500‰), 3 (270‰), and 1 (177‰) year-old fish were abundant (Table 42).

The average number of vertebrae in the three months were 56.60, 56.67, and 56.46 respectively (Table 43).

It seems that the stock was presumably a mixture of the different autumn groups, of which the Bank group was predominant (Tables 44—46).

8. German Bight

Nine samples, with 7,710 herring were investigated in February, March, June, October, November, and December. The average length was in

February 11.83 cm, March 11.73 cm, June 15.53 cm, October 9.60 cm, November 11.32 cm, and December 11.21 cm (Table 40). All catches were of immature fish (Table 41). From February to October the catches consisted of the 1957 year-class and from October to December of the 1958 year-class (Table 42). The total number of vertebrae was from February to June 56.55, 56.60, and 56.69, and from October to December 56.30, 56.59, and 56.47 respectively (Table 43). The stock from February to June appeared to be composed mostly of the Downs group, whereas in autumn the Bank group was predominant (Tables 44 and 45).

9. The Channel

Only five samples of 763 herring were taken from this area. Two came from Sandettié in November and December, and three from Dieppe in January, November, and December. The average length was in the Sandettié area 23.31 cm and 23.12 cm and

Table 42. Age composition of all samples ($\%$)

Area Month Year-class	Age	Viking Bank/Utsira					Bressay Shoal		Fladen Ground				North- Minch VIII
		II	III	V	VII	X	VI	VII	VII	VIII	IX	XI	
1958	1	—	—	—	—	—	—	—	—	—	—	—	—
57	2	—	—	—	101	177	—	—	—	6	7	42	60
56	3	246	149	232	510	490	662	945	754	301	785	737	290
55	4	20	26	137	65	115	119	44	106	57	45	21	160
54	5	173	145	279	80	73	115	11	78	108	75	126	310
53	6	54	87	147	68	31	29	—	23	131	34	11	100
52	7	116	145	79	99	10	43	—	23	222	27	—	30
51	8	54	67	58	39	21	7	—	8	97	10	31	10
50	9	69	82	26	17	10	11	—	3	34	7	21	10
49	10	82	103	16	7	21	7	—	—	22	—	11	30
<49	>10	186	196	26	14	52	7	—	5	22	10	—	—
Total ...		1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number .		648	194	190	414	96	278	180	387	176	292	95	100

Area Month Year-class	Age	Gut		Dogger Bank			SW of Egersund			Skagerak	Sandettié	Channel Dieppe	
		VII	X	VII	IX	X	VII	XI	XII	XI	XI	I	XII
1958	1	—	—	—	—	+	—	7	—	5	—	—	—
57	2	129	140	590	119	298	83	21	21	810	10	18	20
56	3	668	674	400	691	491	508	751	569	175	670	38	823
55	4	118	37	10	67	96	26	28	—	5	170	285	41
54	5	43	37	—	41	43	67	91	95	5	70	398	76
53	6	27	17	—	31	15	20	29	63	—	60	161	15
52	7	5	44	—	26	19	88	36	95	—	10	28	10
51	8	—	10	—	10	10	47	7	74	—	10	18	10
50	9	5	—	—	5	3	5	5	42	—	—	9	5
49	10	5	14	—	5	5	26	3	10	—	—	18	—
<49	>10	—	27	—	5	20	130	22	31	—	—	27	—
Total ...		1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number .		186	294	300	194	2466	193	581	95	200	100	106	197

Area Month Year-class	Age	East of Dogger			German Bight				South Ireland		North Ireland	
		I	VI	X	II	III	VI	X	XI	XII	I	XI
1958	1	—	—	177	—	—	—	1000	1000	1000	—	—
57	2	949	970	500	1000	1000	1000	—	—	—	6	—
56	3	51	30	270	—	—	—	—	—	—	23	341
55	4	—	—	35	—	—	—	—	—	—	32	94
54	5	—	—	18	—	—	—	—	—	—	269	265
53	6	—	—	—	—	—	—	—	—	—	146	128
52	7	—	—	—	—	—	—	—	—	—	18	18
51	8	—	—	—	—	—	—	—	—	—	187	100
50	9	—	—	—	—	—	—	—	—	—	69	12
49	10	—	—	—	—	—	—	—	—	—	119	12
<49	>10	—	—	—	—	—	—	—	—	—	142	24
Total ...		1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number .		99	100	226	100	100	100	99	200	265	219	170

off Dieppe 25.18 cm, 24.53 cm, and 23.30 cm (Table 40). In the Sandettié area in November maturity stage VI was abundant (900%), together with some stage V (100%). In January off Dieppe stages VII/II and VII were predominant (916%), while in December stage VI (970%) was most frequent (Table 41).

The age composition from Sandettié in November was formed by 3 year-old (810%) and 4 year-old herring (170%). In the Dieppe area in January the 5 (398%), 4 (285%), and 6 (161%) year-old fish

were predominant, whereas in December the 3 year-olds (823%) were most abundant (Table 42).

The average number of vertebrae amounted in November at Sandettié to 56.44, off Dieppe in January 56.65, and in December 56.62 (Table 43).

The meristic characters of the herring from the Sandettié area in November suggest that herring from the Bank group were present, whereas in the Dieppe area in January and December the catch consisted of herring from the Downs group (Tables 44—46).

Table 43. Total number of vertebrae (V.S.) ($^{\circ}/_{00}$)

Area Month	Viking Bank/Utsira					Bressay Shoal		Fladen Ground				North- Minch VIII
	II	III	V	VII	X	VI	VII	VII	VIII	IX	XI	
V.S. 60	I	—	—	—	—	—	—	—	—	—	—	—
59	I	5	—	2	—	—	5	3	—	—	—	—
58	103	122	71	98	53	54	66	53	56	23	71	100
57	556	574	508	490	474	525	467	503	424	515	455	480
56	328	279	386	385	431	384	442	403	485	442	424	380
55	10	20	30	25	42	34	20	38	35	20	50	40
54	—	—	5	—	—	—	—	—	—	—	—	—
53	I	—	—	—	—	—	—	—	—	—	—	—
52	—	—	—	—	—	3	—	—	—	—	—	—
Total	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number	691	197	197	447	95	297	197	395	198	299	99	100
Av. V.S.	56.76	56.81	56.61	56.67	56.54	56.59	56.59	56.58	56.50	56.54	56.55	56.64

Area Month	Gut		Dogger Bank			SW of Egersund			Skagerak	Sandettié	Channel Dieppe	
	VII	X	VII	IX	X	VII	XI	XII	XI	XI	I	XII
V.S. 60	—	—	—	—	—	—	—	—	5	—	—	—
59	—	—	3	—	2	—	6	—	—	—	9	5
58	46	34	34	10	40	71	46	80	91	10	67	66
57	500	470	480	460	475	401	506	550	518	506	533	508
56	444	456	453	490	421	482	418	360	361	402	343	391
55	10	37	30	40	56	46	23	10	25	82	48	30
54	—	—	—	—	6	—	1	—	—	—	—	—
53	—	3	—	—	—	—	—	—	—	—	—	—
52	—	—	—	—	—	—	—	—	—	—	—	—
Total	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number	196	296	296	200	2463	197	588	100	197	97	105	197
Av. V.S.	56.58	56.49	56.53	56.44	56.49	56.50	56.59	56.70	56.70	56.44	56.65	56.62

Area Month	East of Dogger Bank			German Bight						South Ireland		North Ireland	
	I	VI	X	II	III	VI	X	XI	XII	I	XII	X	XI
V.S. 60	—	—	—	—	—	—	—	—	—	—	—	—	—
59	—	—	—	—	—	—	—	5	—	—	—	—	10
58	82	53	40	40	21	75	31	51	62	171	165	112	206
57	480	577	444	485	573	548	320	518	413	645	610	582	444
56	408	354	460	455	396	366	567	391	464	184	214	286	310
55	20	16	48	20	10	11	82	30	58	—	11	20	30
54	10	—	8	—	—	—	—	5	3	—	—	—	—
53	—	—	—	—	—	—	—	—	—	—	—	—	—
52	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number	98	189	252	99	96	93	97	197	259	245	187	98	97
Av. V.S.	56.60	56.67	56.46	56.55	56.60	56.69	56.30	56.59	56.47	56.99	56.93	56.79	56.86

Table 44. Total number of vertebrae (V.S.) in relation to stages of maturity

Area Month Stages of maturity	Viking Bank/Utsira						Bressay Shoal		
	II No. Aver.	III No. Aver.	V No. Aver.	VII No. Aver.	X No. Aver.		VI No. Aver.	VII No. Aver.	
I	162 56.58	30 56.57	35 56.60	113 56.88	19 56.58		37 56.89	7 56.57	
II	261 56.58	25 56.32	107 56.60	156 56.76	26 56.50		126 56.59	11 56.45	
III	7 57.00	—	19 56.47	101 56.42	5 56.80		97 56.53	98 56.54	
IV	25 57.12	2 57.00	2 57.00	74 56.49	10 56.60		35 56.43	78 56.64	
V	99 57.07	34 56.97	—	3 56.00	13 56.38		2 56.50	2 57.50	
VI	114 57.05	62 57.08	—	—	1 56.00		—	1 58.00	
VII	4 57.50	13 56.70	—	—	4 56.75		—	—	
VII/II	19 56.58	31 56.74	34 56.71	—	17 56.52		—	—	
Total/Mean	691 56.76	197 56.81	197 56.61	447 56.67	95 56.54		207 56.59	197 56.59	

Table 44 (continued)

Area	Fladen Ground				North Minch		Gut	
Month	VII		VIII		XI		VIII	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	33	56.73	20	56.60	10	56.40	18	57.00
II	66	56.62	5	56.80	80	56.54	9	57.00
III	182	56.58	11	56.55	2	58.00	12	56.75
IV	106	56.50	47	56.53	—	—	29	56.59
V	8	56.63	104	56.43	—	—	32	56.34
VI	—	—	—	—	—	—	1	57.00
VII	—	—	9	56.67	—	—	—	—
VII/II	—	—	2	56.50	7	56.43	—	—
Total/Mean	395	56.58	198	56.50	99	56.55	100	56.64
Area	Dogger Bank				SW of Egersund		Skagerak	
Month	VII		IX		XI		XII	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	215	56.54	30	56.23	53	56.72	72	56.64
II	38	56.50	6	56.33	37	56.62	461	56.55
III	29	56.31	18	56.61	126	56.56	27	57.07
IV	14	56.79	15	56.53	331	56.49	6	57.17
V	—	—	22	56.45	415	56.50	2	56.00
VI	—	—	64	56.49	71	56.50	1	58.00
VII	—	—	34	56.35	136	56.49	—	—
VII/II	—	—	11	56.73	347	56.47	5	57.00
Total/Mean	296	56.53	200	56.44	2,463	56.49	100	56.70
Area	Channel				East of Dogger Bank			
Month	XI		I		XII		I	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	—	—	3	56.67	1	55.00	98	56.60
II	—	—	3	56.00	—	—	—	—
III	—	—	—	—	—	—	—	—
IV	—	—	—	—	—	—	—	—
V	10	56.60	2	56.50	5	56.40	—	—
VI	87	56.43	1	56.00	191	56.64	—	—
VII	—	—	16	56.75	—	—	—	—
VII/II	—	—	80	56.66	—	—	—	—
Total/Mean	97	56.44	105	56.65	197	56.62	98	56.60
Area	German Bight							
Month	II		III		VI		XI	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	99	56.55	96	56.60	93	56.69	97	56.30
II	—	—	—	—	—	—	—	—
III	—	—	—	—	—	—	—	—
IV	—	—	—	—	—	—	—	—
V	—	—	—	—	—	—	—	—
VI	—	—	—	—	—	—	—	—
VII	—	—	—	—	—	—	—	—
VII/II	—	—	—	—	—	—	—	—
Total/Mean	99	56.55	96	56.60	93	56.69	97	56.30
Area	South Ireland				North Ireland			
Month	I		XII		X		XI	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	1	57.00	—	—	1	57.00	—	—
II	—	—	—	—	18	56.50	21	56.43
III	—	—	—	—	12	56.92	11	57.09
IV	—	—	4	57.25	58	56.88	58	57.09
V	1	56.00	54	56.87	—	—	—	—
VI	183	56.99	110	56.91	—	—	—	—
VII	59	57.02	18	57.22	2	56.50	—	—
VII/II	—	—	1	56.00	7	56.57	7	56.00
Total/Mean	245	56.99	187	56.93	98	56.79	97	56.86

Table 45. Keeled scales (K_2) in relation to stages of maturity

Area Month	Viking Bank/Utsira						Bressay Shoal	
	II	III	V	VII	X		VI	VII
Stages of maturity	No. Aver.	No. Aver.	No. Aver.	No. Aver.	No. Aver.		No. Aver.	No. Aver.
I	151 14.21	26 13.92	24 14.21	103 14.08	21 14.57		32 14.22	7 13.86
II	251 14.59	24 14.38	91 14.40	139 14.11	23 14.26		111 14.52	9 14.00
III	7 13.43	—	16 14.63	92 14.41	5 14.40		87 14.53	89 14.12
IV	24 14.00	2 13.50	2 14.50	70 14.54	10 14.70		28 14.29	79 13.56
V	100 13.90	34 13.71	—	3 14.67	13 14.69		1 14.00	2 13.50
VI	109 13.94	59 13.81	—	—	1 15.00		—	1 15.00
VII	4 14.00	12 14.28	—	—	3 14.67		—	—
VII/II	18 14.72	32 14.66	30 14.67	—	18 14.78		—	—
Total/Mean	604 14.26	189 14.04	163 14.44	407 14.25	94 14.56		259 14.46	187 14.04
Area Month	Fladen Ground				North Minch		Gut	
	VII	VIII	IX	XI	VIII		VII	X
Stages of maturity	No. Aver.	No. Aver.	No. Aver.	No. Aver.	No. Aver.		No. Aver.	No. Aver.
I	29 14.31	19 14.16	31 14.07	10 14.40	16 14.25		52 14.27	61 14.13
II	61 14.54	5 13.80	81 14.04	80 14.36	9 14.33		32 14.56	108 14.31
III	173 14.40	11 14.64	1 15.00	1 15.00	11 14.45		59 14.56	21 14.95
IV	105 14.43	46 14.76	3 14.00	—	28 14.32		26 14.38	9 14.44
V	8 14.38	99 14.70	20 14.85	—	27 14.37		1 14.00	12 14.83
VI	—	—	—	—	—		—	2 15.50
VII	—	10 14.40	45 14.44	—	—		—	11 14.82
VII/II	—	2 16.00	103 14.14	7 14.71	—		—	66 14.58
Total/Mean	376 14.42	192 14.63	284 14.20	98 14.40	91 14.34		170 14.44	290 14.43
Area Month	Dogger Bank			SW of Egersund			Skagerak	
	VII	IX	X	VII	XI	XII	XI	
Stages of maturity	No. Aver.	No. Aver.	No. Aver.	No. Aver.	No. Aver.	No. Aver.	No. Aver.	
I	165 14.62	22 14.59	781 14.49	48 14.25	68 14.31	4 14.25	170 14.33	
II	34 14.56	5 14.40	239 14.39	34 14.44	443 14.30	65 14.58	16 14.44	
III	21 14.10	18 14.72	124 14.68	55 14.40	28 13.93	1 15.00	1 14.00	
IV	13 14.54	12 14.33	327 14.68	46 14.57	6 13.67	8 13.63	1 15.00	
V	—	22 14.86	403 14.84	2 14.50	1 15.00	3 14.33	—	
VI	—	62 14.52	73 14.73	—	—	—	—	
VII	—	33 14.58	134 14.59	—	—	5 14.80	—	
VII/II	—	8 14.38	338 14.49	—	21 14.81	10 14.20	2 14.00	
Total/Mean	233 14.56	182 14.58	2419 14.58	185 14.41	567 13.30	96 14.46	190 14.34	
Area Month	Sandettié		Dieppe		East of Dogger			X
	XI		I	XII	I	VI		
Stages of maturity	No. Aver.		No. Aver.	No. Aver.	No. Aver.	No. Aver.		No. Aver.
I	—	—	3 15.33	1 14.00	98 14.70	129 14.96	167 14.89	
II	—	—	3 14.00	—	—	—	12 14.00	
III	—	—	—	—	—	—	14 14.13	
IV	—	—	—	—	—	—	18 14.72	
V	10 14.80	—	2 14.50	5 14.40	—	—	19 14.63	
VI	85 14.85	—	1 14.00	189 14.73	—	—	6 14.67	
VII	—	—	15 14.87	—	—	—	16 14.69	
VII/II	—	—	79 14.81	—	—	—	3 15.33	
Total/Mean	95 14.84	—	103 14.80	195 14.77	98 14.70	129 14.96	255 14.82	
Area Month	German Bight						X	
	II	III	VI	X	XI	XII		
Stages of maturity	No. Aver.	No. Aver.	No. Aver.	No. Aver.	No. Aver.	No. Aver.	No. Aver.	No. Aver.
I	98 15.06	97 15.02	75 14.99	96 15.09	184 14.95	253 14.95	—	
II	—	—	—	—	—	—	—	
III	—	—	—	—	—	—	—	
IV	—	—	—	—	—	—	—	
V	—	—	—	—	—	—	—	
VI	—	—	—	—	—	—	—	
VII	—	—	—	—	—	—	—	
VII/II	—	—	—	—	—	—	—	
Total/Mean	98 15.06	97 15.02	75 14.99	96 15.09	184 14.95	253 14.95	—	

Table 45 (continued)

Area Month Stages of maturity	South Ireland		North Ireland	
	I No. Aver.	XII No. Aver.	X No. Aver.	XI No. Aver.
I	1 15.00	— —	1 13.00	— —
II	— —	— —	18 14.78	20 14.35
III	— —	— —	12 14.33	10 13.90
IV	— —	4 14.25	55 14.38	57 14.12
V	1 14.00	54 14.59	— —	— —
VI	183 14.52	110 14.60	— —	— —
VII	59 14.75	17 14.94	3 13.67	— —
VII/II	1 14.00	1 13.00	7 15.00	6 14.50
Total/Mean	245 14.58	186 14.61	96 14.46	93 14.17

Table 46. Gill rakers in relation to stages of maturity

Area	Viking Bank/Utsira								Bressay Shoal					
Month	II		III		V		VII		X		VI		VII	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I.....	161	47.17	30	47.73	35	47.14	111	47.21	21	45.90	37	47.95	6	47.17
II.....	263	46.60	25	46.60	108	46.63	155	47.83	26	46.00	126	46.63	11	46.27
III.....	7	48.00	—	—	18	46.50	98	46.72	5	45.20	99	46.68	97	47.19
IV.....	25	48.00	2	48.00	2	45.50	75	47.00	10	45.30	35	46.49	79	47.25
V.....	100	48.21	34	48.85	—	—	3	46.67	13	45.54	2	46.50	2	45.50
VI.....	114	48.65	62	48.47	—	—	—	—	1	46.00	—	—	1	49.00
VII.....	4	48.00	13	47.31	—	—	—	—	5	46.20	—	—	—	—
VII/II.....	20	46.70	33	46.58	35	46.66	—	—	17	46.12	—	—	—	—
Total/Mean.....	694	47.38	199	47.79	198	46.71	442	47.18	98	45.84	299	46.79	196	47.15

Area	Fladen Ground				North Minch		Gut							
Month	VII		VIII		IX		XI		VIII		VII		X	
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	34	47.82	20	47.80	36	47.58	10	46.30	18	48.33	60	46.12	65	45.97
II	68	46.24	5	47.00	84	47.55	81	46.88	9	48.00	34	46.65	111	46.82
III	182	46.85	11	46.17	1	45.00	2	47.00	12	47.50	67	46.51	21	45.48
IV	107	46.80	48	46.10	2	47.00	—	—	29	46.59	29	46.79	9	45.89
V	8	46.63	104	46.36	20	46.80	—	—	32	46.50	1	48.00	12	46.17
VI	—	—	—	—	—	—	—	—	—	—	—	—	2	48.00
VII	—	—	10	46.90	47	47.06	—	—	—	—	—	—	11	46.64
VII/II	—	—	2	47.00	106	47.01	7	47.00	—	—	—	—	67	46.64
Total/Mean	399	46.81	200	46.48	296	47.22	100	46.83	100	47.11	191	46.46	298	46.49

Area	Dogger Bank				SW of Egersund				Skagerak					
Month	VII		IX		X		VII		XI	XII	XI			
Stages of maturity	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.		
I	216	45.27	30	45.73	789	45.85	53	46.19	72	46.60	5	46.80	179	46.55
II	39	46.08	6	46.50	246	46.09	37	46.68	462	46.88	68	46.75	17	47.12
III	29	46.62	17	46.35	160	45.54	60	46.70	28	47.89	1	47.00	1	46.00
IV	14	46.57	14	45.64	299	45.52	47	46.55	6	47.83	8	48.25	1	47.00
V	—	—	22	46.64	410	45.68	2	44.50	1	49.00	3	48.00	—	—
VI	—	—	63	46.60	69	46.06	—	—	—	—	—	—	—	—
VII	—	—	34	46.82	134	45.95	—	—	—	—	5	46.20	—	—
VII/II	—	—	11	47.55	348	46.12	—	—	21	45.57	10	45.80	2	45.50
Total/Mean	298	45.57	197	46.47	2455	45.84	199	46.50	590	46.86	100	46.87	200	46.59

Area Month Stages of maturity	Channel													
	Sandettié		Dieppe				South Ireland				North Ireland			
	XI		I		XII		I		XII		X		XI	
	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
I	—	—	3	45.33	1	45.00	1	47.00	—	—	1	47.00	—	—
II	—	—	3	45.67	—	—	—	—	—	—	18	46.89	21	46.76
III	—	—	—	—	—	—	—	—	—	—	12	48.17	10	48.10
IV	—	—	—	—	—	—	—	—	4	45.75	59	48.34	59	48.12
V	10	45.90	2	44.50	5	44.60	1	45.00	54	46.91	—	—	—	—
VI	89	45.82	1	45.00	191	45.51	186	46.80	111	46.96	—	—	—	—
VII	—	—	16	45.56	—	—	59	46.98	18	46.83	3	45.67	—	—
VII/II	—	—	81	45.52	—	—	1	48.00	1	46.00	7	46.57	7	47.86
Total/Mean	99	45.83	106	45.50	197	45.48	248	47.03	188	46.90	100	47.84	97	47.80

10. South Ireland

From the Dunmore area, 12 samples with 1,737 herring were investigated. The average lengths of the trawled herring was 27.84 and 28.06 cm in January and 28.68 cm in December (Table 40). Maturity stages VI ($740^0/00$) and VII ($243^0/00$) predominated in January, whereas in December stages VI ($591^0/00$) and V ($287^0/00$) were the most abundant (Table 41). The age composition shows the predominance of the 5 ($260^0/00$), 8 ($187^0/00$), 6 ($146^0/00$), and 10 year-old and older herring ($261^0/00$) in January, while in December the sequence of the age-groups were the following: 3 ($341^0/00$), 5 ($265^0/00$), 6 ($128^0/00$), and 8 year-olds ($100^0/00$) (Table 42).

The average number of vertebrae was 56.99 and 56.93 (Table 43). The average vertebral count for maturity stage VI was 56.99, keeled scales 14.52 and 14.60, and gill rakers 46.80 and 46.96 (Tables 44—46).

11. North Ireland (Klondyke)

Two samples in October and November, containing 907 herring were analysed. The average length was 30.63 cm and 30.68 cm (Table 40). The catches, comprising mostly prespawning herring between maturity stages III and IV, contained a predominance of stage IV ($590-610^0/00$) fish (Table 41). The age composition shows the predominance of the 6, 5, 8, and 7 year-old herring (Table 42).

The average number of vertebrae was 56.79 and 56.86 cm (Table 43). After the meristic characters the catch was a mixture of autumn (stage II) and late winter spawners (stage III/IV) (Tables 44—46).

Summary

The catch of the German fishing fleet rose in 1959 by about 8.3%. This was mainly due to the larger catches in the North Sea and the Channel. The hydrographic situation in the North Sea in 1959 was similar to 1955. The catch per day increased on all fishing grounds (Fladen, Gut, Dogger, Channel) due to the appearance of the strong 1956 year-class. In September and October 1958 large shoals of 2 year-old herring (1956 year-class) were present in the Gut, and NNW of the Dogger Bank; they were characterized by special meristic characters and could be traced in the late autumn, winter, and spring in the Egersund, Skagerak, and Utsira areas. In the summer of 1959, they were found in the Fladen area and the Gut, but they did not appear on the Dogger Bank. There a spawning took place round the Dogger in different localities. The strong 1956 year-class which appeared on these grounds, however, showed the usual meristic

characters of the Bank herring. The striking feature of 1959 was the rejuvenescence of the adult Bank stock by the strong 1956 year-class.

K. SCHUBERT

The Herring Fisheries of the Netherlands in 1959

(Figure 15; Charts 36-51; Tables 47-48)

A. The Fisheries

Trawl

Information on the 1959 herring trawl fishery is supplied in Table 47. In this table the total catch, the effort (in fishing hours, converted to a motor-trawler of 500 B.H.P.) and the catch per 100 hours' fishing is shown by month and by area. The subdivisions of the North Sea used here are:

- (1) NE. The Area east of 2°E and north of $57^{\circ}30'\text{N}$.
- (2) NW. The area west of 2°E and north of 56°N .
- (3) Central. The area north of $53^{\circ}30'\text{N}$ but south of areas NE and NW.
- (4) South. The area south of $53^{\circ}30'\text{N}$, including the eastern part of the English Channel.

The area SE Ireland covers mainly the Smalls area and the Dunmore area.

The quantities shown are converted landings and give an approximation of the actual catch (conversion factor = 1.17). It should be noted that quantities given in preceding volumes of *Annales Biologiques* were landings and were not converted to fresh weight.

A comparison with 1958 shows a decline in the catches in the NE area of the North Sea and SE Ireland, but an increase in all other areas. The decline in area NE was mainly caused by a less successful spring fishery, presumably on herring mainly of Atlanto-Scandian origin.

The total catches in the North Sea areas NW and central were twice those of 1958, while the catches per effort rose by 70% and 30% respectively. An extremely good recruitment to these areas was probably responsible for the catch improvements.

In the North Sea area, south, catches were also far better than in 1958. The catch per effort went up by approximately 90%, which forms a striking contrast with the very poor drift-net fishery in this area. As will be mentioned below, a difference in recruitment may have been responsible for this discrepancy.

As a whole, the 1959 trawl fishery gave better results than those in 1958, the total catch increased from 45,000 tons to 61,800 tons.

Table 47. Catch and effort data of the herring trawl fisheries in 1959

Top figures: total catch in tons.

Middle figures: effort in $\frac{\text{fishing hours}}{100}$ of a motortrawler of 500 B.H.P.

Bottom figures: catch per 100 hours' fishing.

Area	Jan.	Febr.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Total
NE	825.7 100.3 8.3	338.9 83.0 4.1	538.2 93.9 5.7	1,130.2 103.6 10.9	482.4 93.9 5.1	337.3 48.0 7.0	206.4 26.2 7.8	938.4 63.1 14.9	2,092.7 83.0 25.2	1,642.8 126.7 13.0	1,913.5 116.0 16.5	1,139.2 75.9 15.0	11,585.8 1,013.1 11.5
NW	—	51.6 13.7 3.7	38.7 6.2 6.0	323.0 53.7 6.8	171.4 26.0 6.8	3,677.8 97.9 37.6	8,722.5 140.6 62.0	6,512.3 105.7 61.7	190.0 2.9 65.5	210.6 13.5 15.6	180.9 7.8 23.3	1.9 1.1 1.6	20,086.7 469.1 42.8
Central	—	42.7 0.5 80.5	2.5 1.2 2.0	36.9 19.3 1.9	42.0 69.3 0.6	90.1 34.1 2.7	551.4 40.3 13.7	4,624.4 68.4 67.6	12,195.7 129.8 94.0	4,692.9 77.5 60.7	—	—	22,278.6 440.4 50.5
South	—	2.9 0.7 4.3	—	—	—	—	—	—	—	1,669.0 10.3 161.7	2,530.0 12.9 196.4	4,201.9 23.9 175.8	—
SE Ireland ...	1,120.9 9.0 124.1	143.4 2.0 71.7	—	0.4 4.1 0.1	—	—	—	914.5 13.8 66.2	338.1 6.9 49.0	158.0 6.7 23.5	170.9 21.3 8.0	809.8 3.9 207.6	3,655.9 67.7 54.0

Table 48. Catch and effort of drift-net fisheries in 1959

Top figures: total catch in tons.

Middle figures: effort in number of shots.

Bottom figures: catch per shot in tons.

Area	Jan.	Febr.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
NE	—	6.1 ? ?	22.2 ? ?	74.4 ? ?	—	—	—	—	—	—	—	—	—
NW	—	—	—	—	1,310.9 801 1.6	5,182.5 2,683 1.9	4,632.8 1,296 3.6	4,637.9 831 5.6	2,348.6 602 3.9	—	—	—	18,112.8 6,213 2.9
Central	—	—	—	—	8.4 12 0.7	39.8 54 0.7	4,321.9 1,408 3.1	7,016.8 1,499 4.7	4,952.4 1,840 2.7	7,248.9 1,752 4.1	18.4 11 1.7	—	2,360.6 6,576 3.6
South	—	—	—	—	—	—	—	—	1,959.0 692 2.8	5,326.1 2,320 2.3	294.4 161 1.8	7,579.5 3,173 2.4	—

Drift-net

The drift-net fishery operated in the period from May to December, apart from an insignificant fishery in February—April in the NE area of the North Sea.

Detailed information on the geographical distribution of catches and effort are shown in Charts 36—51. Charts 36—43 show the monthly distribution of the hauls, and Charts 44—51, the average catch per haul. The figures do not present the total activity of the drift-net fleet, but only the part on which detailed information was available (83%).

In addition to the detailed information given in the charts, Table 48 shows the monthly distribution of the total catch (1.17 × the total landings) for each of the areas used for the trawl fisheries.

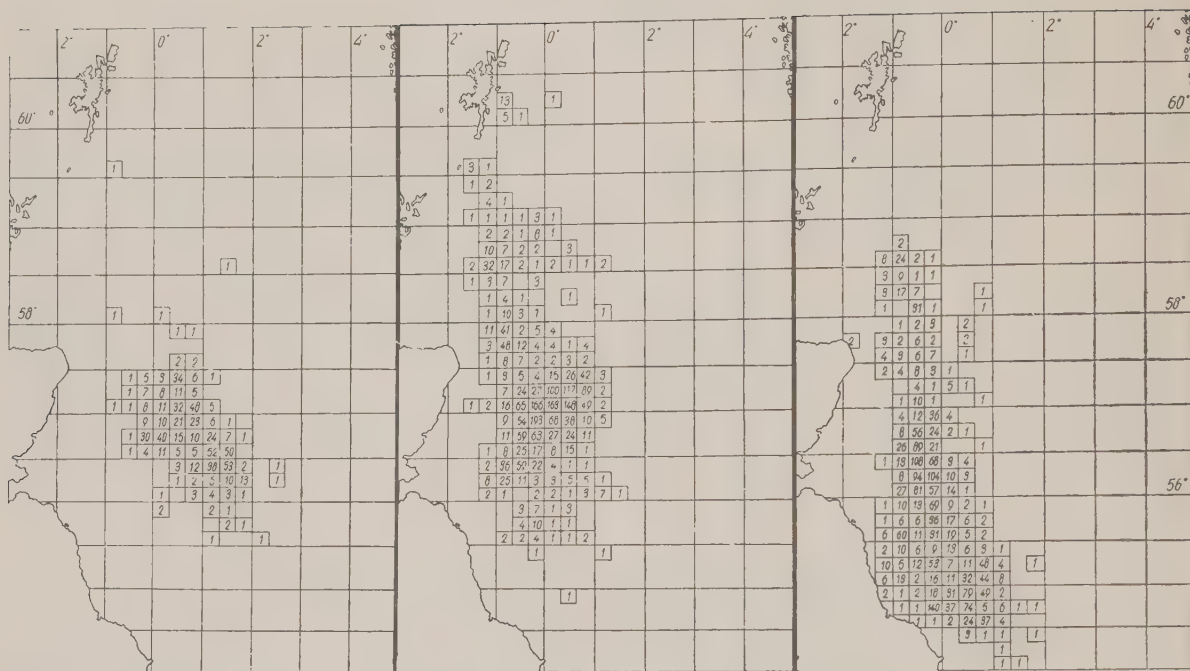
Fishing started on 19. May. Up to 1. July, the number of nets used was restricted to 100 per ship. Thereafter the number of nets was unlimited and in general 100—120 nets were shot per ship.

The results of the drift-net fishery in 1959 can be summarized as follows:—

The summer fishery (May—August) was moderately good and the average catch per haul was in fact higher than in 1958. Catches tended to be better in the northern part of the fishing area. The autumn catches in the central North Sea (September—October) showed a slight improvement over 1958.

The season in the area, south, which is mainly the Dutch counterpart of the East Anglia fishery, and represents the back-bone of the drift-net fishery of the Netherlands, was very unsatisfactory indeed.

Number of Hauls

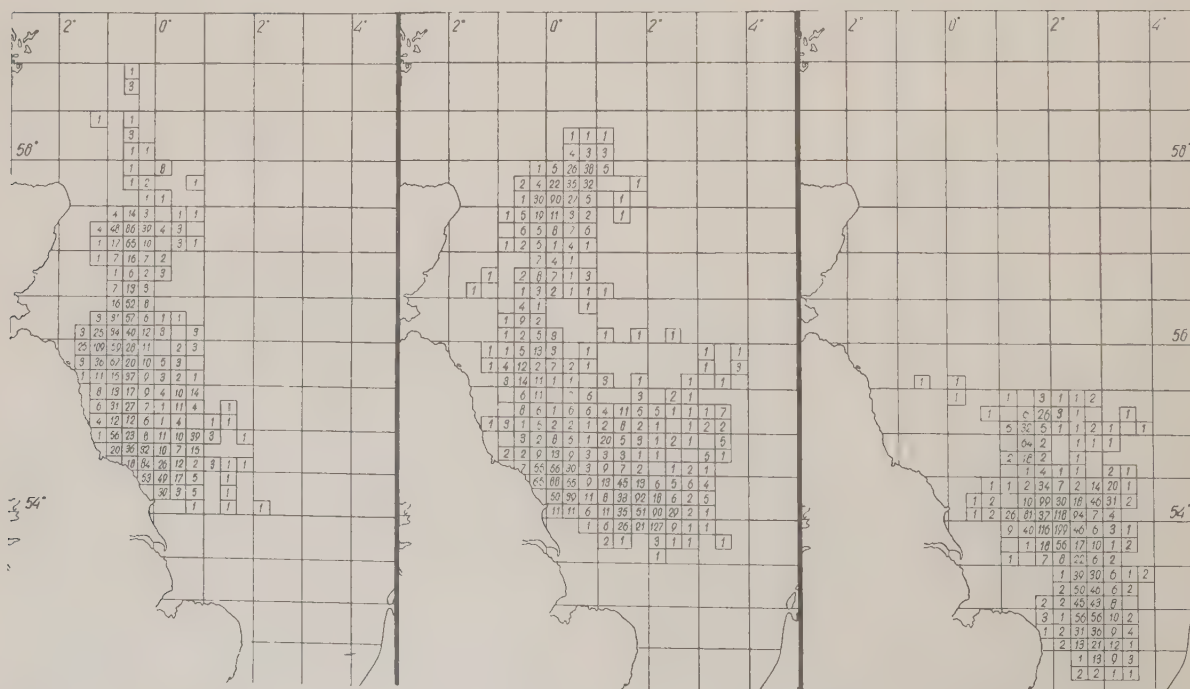


Charts 36-38.

May

June

July



Charts 39-41.

August

September

October

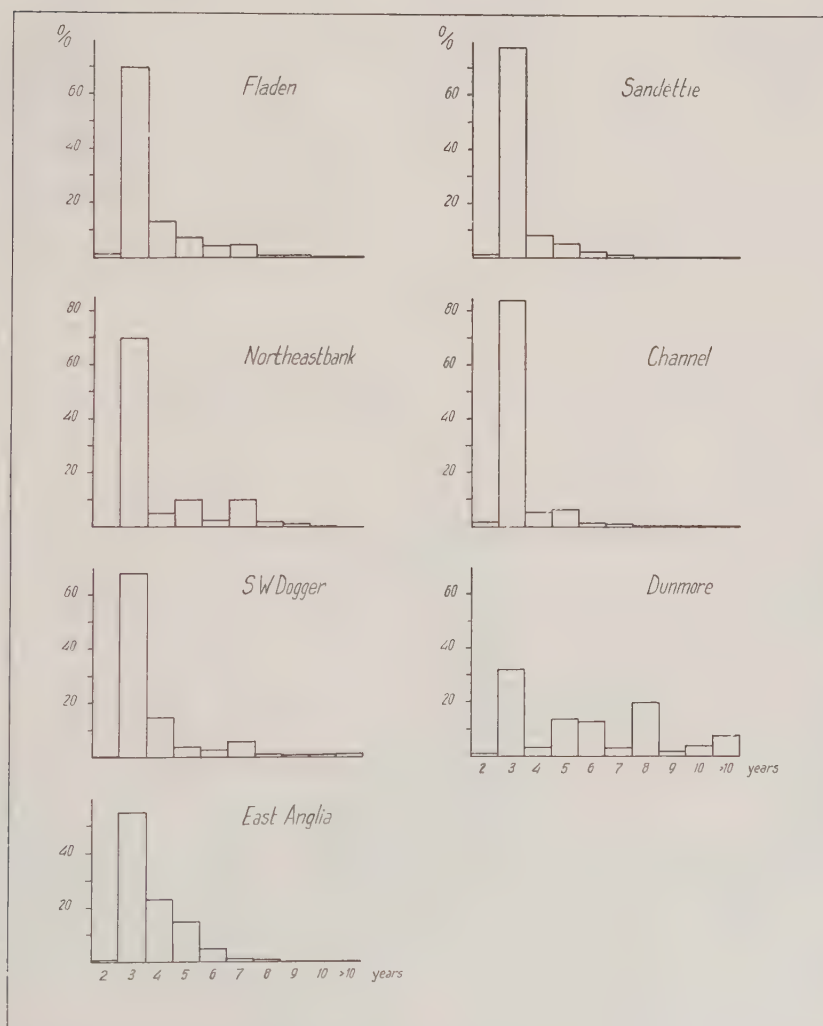
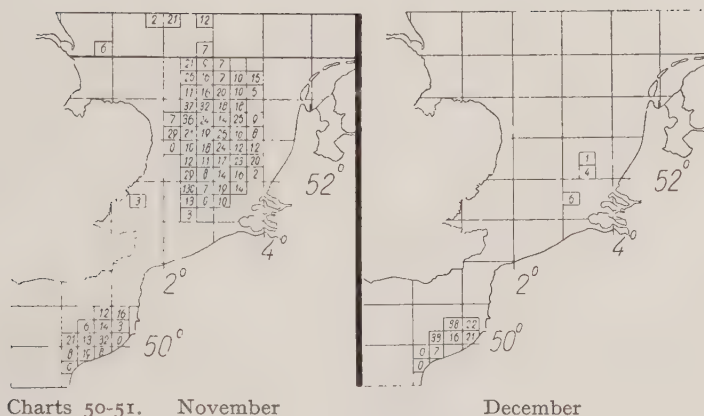
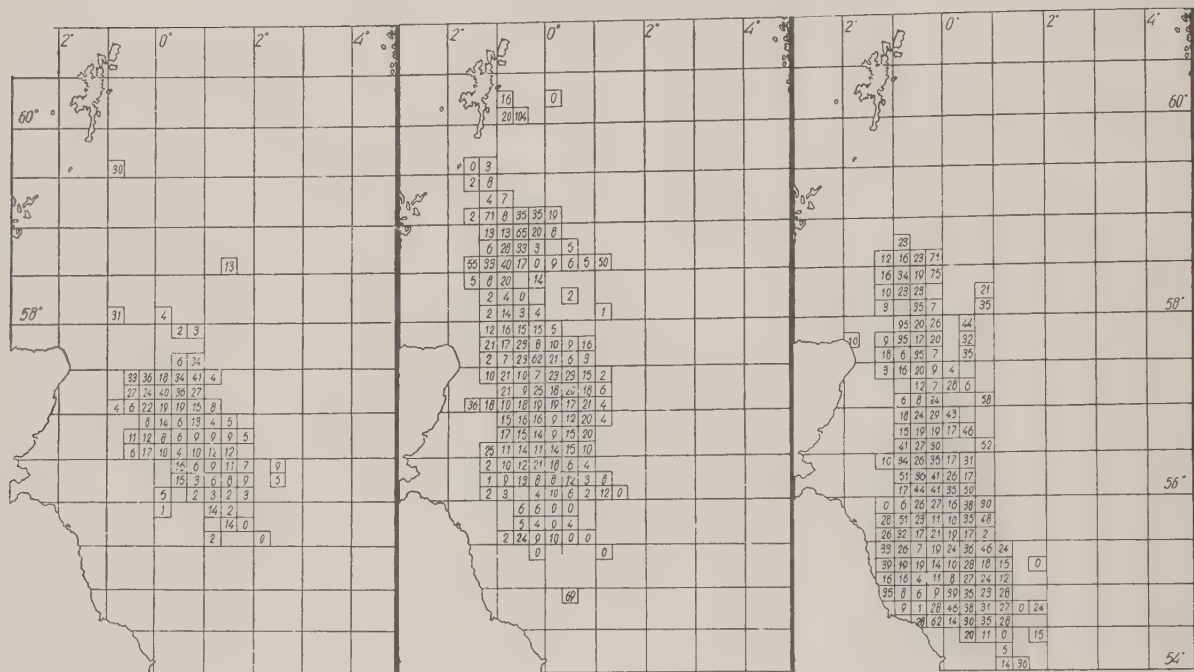


Figure. 15. Age composition of trawl herring samples from the Fladen, NE Bank, SW Dogger, Sandettié, English Channel, and Dunmore area, and of drift-net samples from the southern North Sea.

Mean Catch per Haul (Kantjes)

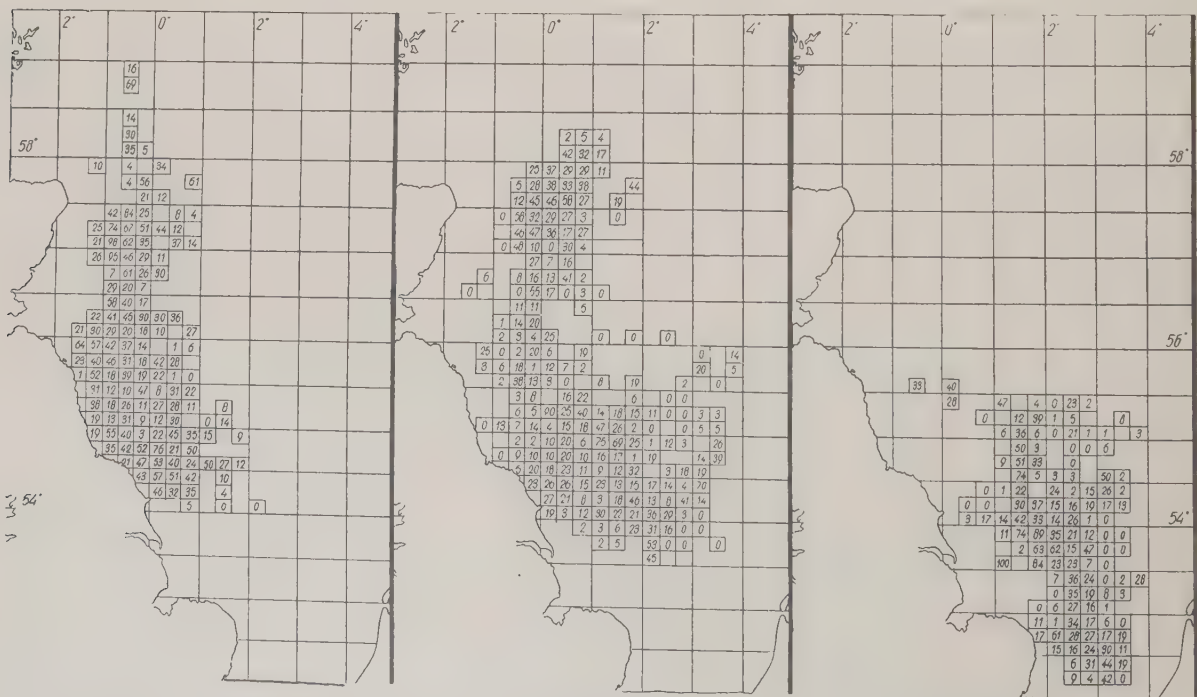


Charts 44-46.

May

June

July



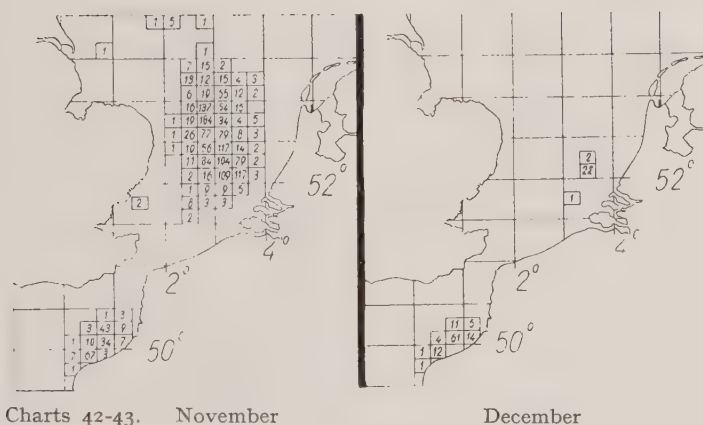
Charts 47-49.

August

September

October

Number of Hauls



Charts 42-43. November

December

The average catch per shot was 2.4 tons as compared with 4.1 tons in 1958, which was then the lowest catch per shot recorded since the war.

Considering the season 1959 as a whole, the drift-net fisheries were not very successful. The total catch (converted landings) was 49,300 tons (1958: 67,700 tons).

B. Biological Data

Age composition

The sampling of commercial catches was concentrated on some well defined fishing localities. Those selected amongst the herring trawl fishery were:—

- (1) The Fladen fishery, carried out in July/August in the region north of 58°N.
- (2) The fishery on the NE Bank (approximate positions: 55°30'N, 0°30'W), in September.
- (3) The fishery on the western and southern edge of the Dogger Bank, in September/October.
- (4) The fishery on the Sandettié Ground, in November.
- (5) The fishery in the English Channel, in December.
- (6) The fishery near Dunmore (SE coast of Ireland) in December 1959/January 1960.

With the exception of the Fladen fishery all these fisheries were carried out on or near spawning areas. Consequently most of the sampled herring in these regions were in maturity stage VI, the percentage of these ripe herring ranging from 60 to 70% in the NE Bank and Dogger Bank fisheries to 90—100% in the Sandettié, Channel, and Dunmore fisheries.

The age compositions are shown in Figure 15. For the Fladen area all maturity stages are incorporated. The age compositions for the other

fisheries are based on herrings in maturity stage VI only.

The only drift-net fishery sampled was that in the East Anglian region (south of 53°30'N), in October/December. The age composition shown is based on herrings in all maturity stages available.

Considering the age compositions of the trawl fisheries in the northern and central North Sea the large proportion of recruits may be noticed. Recruitment was unusually good in these regions and the high catches of the trawlers are probably mainly due to the very strong 1956 year-class. In the Dogger Bank area this year-class was approximately 4—5 times stronger than a normal year-class.

The samples from the southern North Sea show a discrepancy between those of the East Anglian region and those from the trawling grounds on the Sandettié and in English Channel. Normally age compositions in these areas are very similar, but in 1959 recruitment was apparently far better on the spawning grounds than in the East Anglian area. This might explain the different trends in the catches per effort in the two areas; whereas the East Anglia fishery showed a marked decline in 1959, the catches per effort in the trawl fisheries had improved.

The data for 1959 show, again, that recruitment in 1958 had been better on the Sandettié Ground than in the English Channel, which might explain the failure of Channel trawl fishery in 1958.

The Dunmore age composition shows a reasonable recruitment in 1959, with the additional good year-classes 1954, 1953, and 1951.

K. H. POSTUMA

J. J. ZIJLSTRA

The Belgian Herring Fisheries in 1959—1960

(Figure 16; Tables 49—61)

A. The Fisheries

As during previous years, two different kinds of trawl were used, the otter-trawl and the pelagic trawl, the latter towed by two trawlers fishing together. The results obtained by these two fishing methods are given separately.

I. Otter-trawl; regions and periods

Five regions were exploited:—

- (1) Utsira Patch and Coral Bank — September to November.
- (2) Fladen — August to October.
- (3) Dogger Bank — August to October.
- (4) The region S of Ireland — August to November.
- (5) The region N of Ireland — September.

Fishing effort and landings

Tables 49—51 give records of the fishing effort and yields for the fishery in 1959/60. Seven trawlers

took part. These made 31 trips and developed 1,914,670 FH × h. p. The corresponding figures for 1958/59 were: 10 trawlers, 46 trips, and 1,920,930 FH × h. p. (Table 49).

In the previous year 805 tons of herring were landed, this being 189 tons or 23.5% more than in 1959/60. The average catch per trip for all regions together was 20 tons and the catch per 100 FH × h. p. was 32 kg. In 1958/59 these figures were 17.5 tons and 41 kg respectively (Table 51).

II. Pelagic trawl; region and period

The use of the pelagic trawl was restricted to the region covering the L.V. Goeree to Cape Gris-Nez, passing Schouwen Bank, Middle Deep, Thornton Ridge, Ostend Bank, the lightvessel West-Hinder, Sandettié, and Dyck. The first catches were landed on 2. November 1959 and the last on 26. January 1960.

Fishing effort and landings

Table 52 gives a survey of the fishery effort. Thirteen couples took part in the fishery. A total

Table 49. Otter-trawl: Number of trips and fishing effort

Months	Utsira/ Coral Bank		Fladen		Dogger Bank		S Ireland		N Ireland		Total
August	—		4		1		2		—		7
September	3		1		5		3		1		13
October	4		1		3		1		—		9
November	1		—		—		1		—		2
Total 1959	8		6		9		7		1		31
Fishing effort (1,000 FH × h.p.)											
August	—		216		56		163		—		435
September	151		68		306		235		46		806
October	338		42		128		81		—		589
November	73		—		—		12		—		85
Total 1959	562		326		490		491		46		1,915

Table 50. Otter-trawl: Total yields

Species	Utsira/ Coral Bank		Fladen		Dogger Bank		S Ireland		N Ireland		Total	
	Tons	‰	Tons	‰	Tons	‰	Tons	‰	Tons	‰	Tons	‰
Pelagic												
Herring	85.4	367	159.2	803	255.7	864	95.0	524	20.6	713	615.9	657
Mackerel	76.0	327	24.6	124	11.4	39	63.8	352	4.9	170	180.7	193
Others	0.5	2	0.2	1	1.0	3	3.5	20	0.1	3	5.3	6
Total	161.9	696	184.0	928	268.1	906	162.3	896	25.6	886	801.9	856
Demersal												
Haddock	19.6	84	2.3	12	10.3	35	0.1	1	1.1	38	33.4	36
Cod	12.1	52	1.6	8	3.7	12	1.3	7	0.6	21	19.3	20
Saithe	10.2	44	0.7	3	1.5	5	3.2	18	0.7	24	16.3	17
Whiting	16.5	71	8.3	42	9.8	33	9.5	52	0.7	24	44.8	48
Others	12.2	53	1.4	7	2.6	9	4.8	26	0.2	7	21.2	23
Total	70.6	304	14.3	72	27.9	94	18.9	104	3.3	114	135.0	144
Grand Total	232.5	1000	198.3	1000	296.0	1000	181.2	1000	28.9	1000	936.9	1000

Table 51. Otter-trawl: Yields of herring

Months	Total catch (tons)					Total
	Utsira/ Coral Bank	Fladen	Dogger Bank	S Ireland	N Ireland	
August	—	109	43	24	—	176
September	33	34	172	54	21	314
October	42	16	41	17	—	116
November	10	—	—	—	—	10
Total 1959	85	159	256	95	21	616
Average catch per trip (tons)						
August	—	27	43	12	—	25
September	11	34	34	18	21	24
October	10	16	14	17	—	13
November	10	—	—	—	—	5
Total 1959	11	27	28	14	21	20
Average catch per 100 FH $\times$ h.p. (kg)						
August	—	50	77	15	—	40
September	22	50	56	23	45	39
October	12	39	32	20	—	20
November	15	—	—	—	—	13
Total 1959	15	49	52	19	45	32

of 234 voyages were made and 103,330 V $\times$ h. p. (V=voyages) were developed. The corresponding data for 1958/59 were 9 couples, 164 voyages, and 70,554 V $\times$ h. p.

The total catch amounted to 2,287 tons, consisting of 2,164 tons of herring (94.7%), 74 tons of other pelagic fish (3.2%), and 49 tons of demersal fish (2.1%) (Table 53). In the previous season 1,221 tons of herring were landed.

The average catch per voyage reached 9.3 tons and 2,095 kg per 100 V $\times$ h. p. In 1958/59 the values were 7.4 tons and 1,731 kg respectively (Table 54).

B. Biological Data

A total of 1,495 herring was investigated; they were collected on the Dogger Bank (335 — September/October) and at Sandettié (1,160 — November/December/January).

Table 55 shows the size distribution of the herring for each fishing area. The average length and weight and the number of males per mille is also recorded.

Tables 56 and 57 give the stages of maturity for these areas and the quantity of intestinal fat respectively.

The age compositions of the catches are given in Table 58 and Figure 16, which also includes the age compositions for the two previous years. These show that the 3 year-old fish were predominant in both areas.

The average lengths of the year-classes and the growth-rate during the first year (L_1) are given in Table 59.

Table 52. Pelagic trawl: Number of trips and fishing effort

Months	Number of trips	Fishing effort (1,000 V $\times$ h.p.)
November	107	48.3
December	79	33.7
January	48	21.3
Total 1959/60	234	103.3

Table 53. Pelagic trawl: Total yields

Species	Tons	%
Pelagic Herring	2,164	94.7
Pelagic Mackerel	20	9
Pelagic Sprat	5	2
Pelagic Pilchard	39	1.7
Pelagic Others	10	4
Demersal	49	2.1
Total pelagic species	2,238	97.9
Total demersal species	49	2.1
Grand total	2,287	100.0

Table 54. Pelagic trawl: The yields of herring

Months	Total catch (tons)	Average catch per voyage (tons)	Average catch 100 V $\times$ h.p. (kg)
November . .	1,223	11.4	2,529
December . .	551	7.0	1,636
January . . .	390	8.1	1,834
Total 1959/60	2,164	9.3	2,095

The number of vertebrae is shown in Table 60. These data show that in both areas the number of vertebrae varied between 54 and 59, with 54 the predominant number.

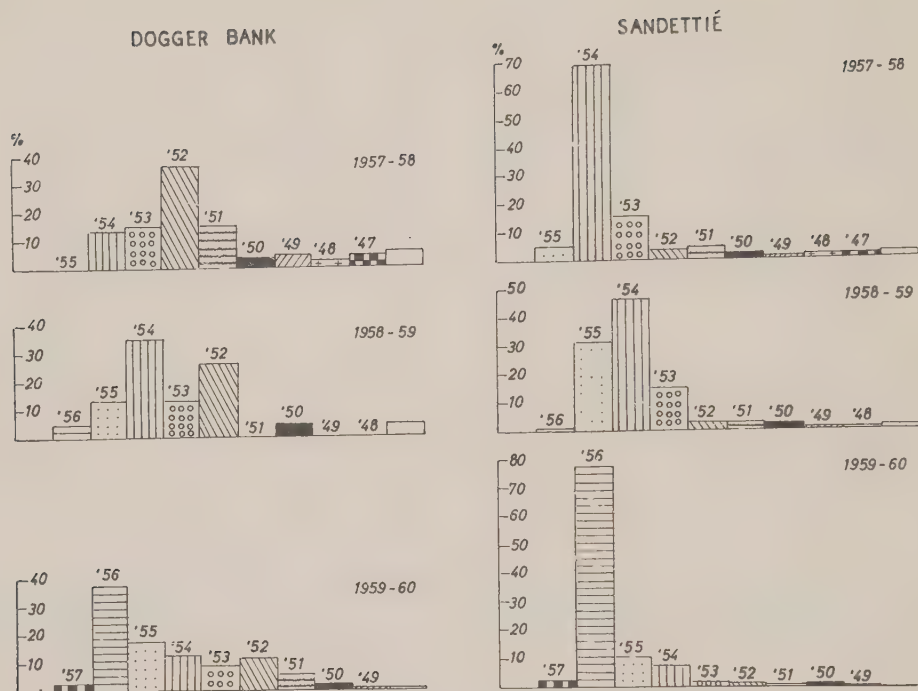


Figure 16. Age compositions of the herring concentrations exploited by the Belgian trawlers on the Dogger Bank and in the Sanddettie area during the period 1957/58-1959/60.

Table 55. Size, weight, and sex (‰)

Cm	Dogger Bank	Sanddettie
32	3	—
31	21	—
30	128	2
29	137	7
28	72	32
27	105	46
26	125	72
25	137	76
24	113	153
23	72	295
22	45	266
21	33	46
20	9	5
Total	1000	1000
Average length, mm	268	240
Mode, cm	25 & 29	23
Weight, g	154	92
Males, ‰	460	491

Table 56. Stages of maturity (‰)

Stages	Dogger Bank	Sanddettie
I	33	8
II	21	15
III	12	—
IV	60	7
V	283	184
VI	194	77
VII	—	19
VIII-II	397	690
Total	1000	1000

Table 57. Quantity of intestinal fat (‰)

Quantity	Dogger Bank	Sanddettie
0	200	304
I	654	661
II	104	29
M	42	6
Total	1000	1000
Index	1.99	1.74

Table 58. Age (‰)

Age	Year-class	Dogger Bank	Sanddettie
2	1957	26	21
3	1956	377	776
4	1955	175	103
5	1954	127	70
6	1953	88	16
7	1952	114	6
8	1951	57	3
9	1950	18	4
10	1949	9	1
+ 10	< 1949	9	—
Total		1000	1000
Average age (years-months)		4.8	3.4

Finally, Table 61 gives the number of keeled scales (K_2) for both areas.

Stomach analyses were made on all herrings investigated. All stomachs of the Dogger Bank herring were empty. Only 12 of those of the Sanddettie area were found to contain food, mostly remains of copepods.

Table 59. Average lengths by year-class and the value of L_1 (mm)

Average length by age, in mm			Average value of L_1 , in mm		
Year-class	Dogger Bank	Sandettié	Year-class	Dogger Bank	Sandettié
1957	212	222	1957	140	148
1956	242	233	1956	126	115
1955	267	261	1955	135	134
1954	284	274	1954	137	125
1953	294	280	1953	133	123
1952	297	288	1952	136	125
1951	303	286	1951	136	147
1950	306	295	1950	126	117
1949	309	300	1949	142	106

Table 60. Vertebrae (V.S. ‰)

V.S.	Dogger Bank	Sandettié
59	—	2
58	67	64
57	462	482
56	432	420
55	39	29
54	—	3
Total	1000	1000
Average	56.556	56.581
Standard error	0.6772	0.6782
Fluctuation mean	0.1259	0.0686

Table 61. Keeled scales (K_2) in ‰

K_2	Dogger Bank	Sandettié
20	3	—
19	—	—
18	3	—
17	21	13
16	93	124
15	413	424
14	359	376
13	102	59
12	6	4
Total	1000	1000
Average	14.578	14.643
Standard error	0.9607	0.8291
Fluctuation mean	0.1778	0.0825

C. Conclusions

As an abnormally high frequency of the youngest age-groups was observed in the material studied during the fishery in 1959/60, it may be expected that the herring concentrations in 1960/61 will once again be characterized by an abundance of 3, 4, and 5 year-old herring and a scarcity of older herring. In consequence the prospects for the coming season are once more rather unpromising.

The alarming, sharp decrease in herring production during the last few years, especially in the Sandettié area, is without doubt caused by different phenomena. There are, however, reasons to

suppose that the ever increasing expansion of the herring fishery, the extreme modernization of the fishing gear, and the apparatus for the detection of the fish shoals are the predominating factors in this herring crisis.

To remedy this situation, a regulation of the herring fishery should be instituted, with special reference to the fisheries in the nursery areas and on the spawning grounds, where the herring stocks are undoubtedly most vulnerable. However, if the prescribed measures are to be efficient, an international agreement should be reached and the countries exploiting the herring fishery in the areas concerned should undertake to observe these measures rigorously.

It is indispensable that this problem should be introduced to the International Commission for the North-East Atlantic Fisheries, as soon as this new organization starts its activities.

CH. GILIS

The Swedish Herring Fishery in the North Sea, Skagerak, and Kattegat in 1959

(Figures 17–21; Chart 52; Tables 62–66)

According to preliminary figures the total yield in 1959 amounted to about 101,500 tons. The main part (about 96%) was taken by trawl; the rest by drift-net and other gears.

Most of the fishery took place in the North Sea; only to a smaller degree was it carried out in the Skagerak and Kattegat.

Some data concerning catch per unit of effort in the Swedish herring fishery have been reported in the *Statistical News Letters*.

The following brief report deals with the results from the examination of 17 samples from commercial catches in different parts of the area and at different times of the year. A number of samples investigated during the set-net fishery in spring for the Skagerak spring spawning herring are not included here.

The most important Swedish fishing grounds in 1959 are shown in Chart 52.

The Skagerak

In recent years this area has been frequented mainly by the smaller fishing vessels. The bigger vessels usually go to the North Sea, and only when bad weather is prevailing do they occasionally stay in the Skagerak. This is due to the fact that since 1955 the fishery here has been poor because only the youngest age-groups of the autumn spawning North Sea herring have been obtainable in the Skagerak; older fish have appeared in this region in very small quantities.



Chart 52. The main Swedish fishing grounds for herring, 1959.

The length distributions of samples taken on four different occasions are given in Table 62 and Figure 17 in which the age composition is also given.

In three of the samples 1-ringers predominated and these undoubtedly belonged to the Bank herring group. In one sample (16. February 1959), however, 0-ringers were more abundant than the 1-ringers, which in this case obviously were of a different kind, possibly belonging to the Downs herring. This is indicated by the lesser total length and the lower L_1 . The maturity stages and the mean vertebral counts are given in Table 63.

The eastern part of northern North Sea

Egersund Bank. The material examined comprised four samples from statistical square K 15. Two of them were taken in November 1958, but are included here to represent early winter condition. The data are given in Tables 62 and 64, and Fig-

ure 18. The November samples could each be split into three different constituents. First the autumn spawners could be separated from the spring spawners from the maturity stages (Table 64). The mean V. S. of the autumn spawning group was found to be 56.60—56.65 and of the spring spawners about 57.0. Their rather high L_1 's (13.8 and 13.4 cm) suggest that they were members of the Bank group. The spring spawners could be further separated into two distinct groups according to the type of their scales: one group had very sharp winter-rings on the scales and also had a low L_1 value (about 8.5 cm); the other had diffuse winter-rings and higher L_1 's (average = 12.2 cm). The first group undoubtedly belonged to the Atlanto-Scandian tribe. This is also suggested by their age composition which showed the same predominant year-class (that of 1950) as in the Norwegian winter fishery. The second spring spawning group showed

Table 62. Length composition of Swedish herring samples

Area Gear Square Date	Skagerak				Eastern part of northern North Sea					
	Pelagic pair-trawl				Pelagic pair-trawl				Bottom-trawl	
	P 14 11. 12. 58	P 15 16. 2. 59	P 15 23. 2. 59	P 14 8. 9. 59	K 15 6. 11. 58	K 15 13. 11. 58	K 15 5. 3. 59	K 15 21. 8. 59	H 17 27. 1. 59	H 18 7. 2. 59
Cm 11.0 ...	—	1	—	—	—	—	—	—	—	—
.5 ...	—	2	1	—	—	—	—	—	—	—
12.0 ...	—	7	—	—	—	—	—	—	—	—
.5 ...	—	8	2	—	—	—	—	—	—	—
13.0 ...	2	14	6	—	—	—	—	—	—	—
.5 ...	5	19	7	—	—	—	—	—	—	—
14.0 ...	2	58	7	—	—	—	—	—	—	—
.5 ...	22	74	10	—	—	—	—	—	—	—
15.0 ...	19	92	23	—	—	—	—	—	—	—
.5 ...	21	92	21	—	—	—	—	—	—	—
16.0 ...	7	84	34	—	—	—	—	—	—	—
.5 ...	7	54	27	—	—	—	—	—	—	—
17.0 ...	7	40	24	—	—	—	—	—	—	—
.5 ...	2	30	7	2	—	—	—	—	—	—
18.0 ...	5	46	11	—	—	—	—	—	—	—
.5 ...	2	58	23	7	—	—	—	—	—	—
19.0 ...	7	67	29	4	—	—	—	—	—	—
.5 ...	14	42	42	27	—	—	—	—	—	3
20.0 ...	12	62	42	38	—	—	—	—	—	—
.5 ...	14	47	65	54	—	—	—	—	—	3
21.0 ...	22	47	72	118	4	—	—	—	—	6
.5 ...	31	27	71	188	—	—	—	—	—	—
22.0 ...	98	16	106	186	4	—	—	5	8	6
.5 ...	86	7	129	195	32	—	12	19	19	45
23.0 ...	172	4	81	120	14	—	15	14	23	80
.5 ...	174	—	58	36	14	—	36	19	58	71
24.0 ...	131	2	59	9	41	—	41	42	69	77
.5 ...	79	—	24	7	9	—	56	61	31	68
25.0 ...	29	—	10	7	—	—	41	70	31	36
.5 ...	17	—	2	2	4	—	47	98	12	27
26.0 ...	5	—	6	—	22	5	36	56	12	18
.5 ...	5	—	—	—	18	—	41	65	42	24
27.0 ...	—	—	—	—	68	22	62	47	66	42
.5 ...	2	—	—	—	76	56	59	88	73	44
28.0 ...	—	—	—	—	41	22	98	47	58	44
.5 ...	—	—	1	—	45	33	145	37	97	68
29.0 ...	—	—	—	—	63	50	92	65	93	56
.5 ...	—	—	—	—	63	67	56	33	104	56
30.0 ...	—	—	—	—	72	56	71	32	69	77
.5 ...	—	—	—	—	45	50	71	60	54	56
31.0 ...	—	—	—	—	86	89	15	60	46	36
.5 ...	—	—	—	—	86	145	6	32	19	33
32.0 ...	—	—	—	—	76	178	—	32	4	12
.5 ...	—	—	—	—	50	100	—	9	4	6
33.0 ...	—	—	—	—	45	89	—	9	4	3
.5 ...	—	—	—	—	22	5	—	—	4	—
34.0 ...	—	—	—	—	—	22	—	—	—	—
.5 ...	—	—	—	—	—	11	—	—	—	—
35.0 ...	—	—	—	—	—	—	—	—	—	—
.5 ...	—	—	—	—	—	—	—	—	—	—
36.0 ...	—	—	—	—	—	—	—	—	—	—
.5 ...	—	—	—	—	—	—	—	—	—	—
37.0 ...	—	—	—	—	—	—	—	—	—	—
.5 ...	—	—	—	—	—	—	—	—	—	3
Total % ₀₀ ..	999	1000	1000	1000	1000	1000	1000	1000	1000	1000
Number ...	119	1183	902	442	222	180	338	215	259	337

Table 62 (continued)

Area Gear Square Date	Western and middle part of northern North Sea Bottom-trawl						Kattegat Drift-net
	G 17 24. 7. 59	G 17 28. 7. 59	E 13 7. 8. 59	E 15 13. 8. 59	G 15 28. 8. 59	G 17 25. 9. 59	Q 13 16. 10. 59
Cm 11.0 ...	—	—	—	—	—	—	—
.5 ...	—	—	—	—	—	—	—
12.0 ...	—	—	—	—	—	—	—
.5 ...	—	—	—	—	—	—	—
13.0 ...	—	—	—	—	—	—	—
.5 ...	—	—	—	—	—	—	—
14.0 ...	—	—	—	—	—	—	—
.5 ...	—	—	—	—	—	—	—
15.0 ...	—	—	—	—	—	—	—
.5 ...	—	—	—	—	—	—	—
16.0 ...	—	—	—	—	—	—	—
.5 ...	—	—	—	—	—	—	—
17.0 ...	—	—	—	—	—	—	—
.5 ...	—	—	—	—	—	—	—
18.0 ...	—	—	—	—	—	—	—
.5 ...	—	—	—	—	—	—	—
19.0 ...	—	—	—	—	3	3	—
.5 ...	—	—	—	—	—	—	—
20.0 ...	—	—	—	—	—	6	—
.5 ...	—	—	3	—	3	7	—
21.0 ...	4	—	6	—	—	3	—
.5 ...	9	3	6	—	—	6	—
22.0 ...	4	6	25	—	9	—	—
.5 ...	32	14	37	4	30	—	—
23.0 ...	123	81	61	7	34	3	12
.5 ...	142	133	67	15	40	3	29
24.0 ...	160	184	160	59	104	10	24
.5 ...	105	156	117	60	132	7	29
25.0 ...	96	132	141	104	122	39	71
.5 ...	46	110	104	78	77	79	88
26.0 ...	87	63	111	126	80	82	129
.5 ...	69	35	61	86	77	108	88
27.0 ...	37	26	34	86	76	125	82
.5 ...	4	6	19	78	46	79	59
28.0 ...	4	9	18	60	61	59	35
.5 ...	14	6	—	41	40	33	18
29.0 ...	9	3	6	48	6	69	12
.5 ...	4	3	12	45	15	36	53
30.0 ...	14	6	9	48	21	56	76
.5 ...	9	3	—	26	9	46	71
31.0 ...	18	6	3	18	3	46	53
.5 ...	9	9	—	4	6	33	35
32.0 ...	—	3	—	7	—	26	12
.5 ...	—	3	—	—	—	23	18
33.0 ...	—	—	—	—	6	13	6
.5 ...	—	—	—	—	—	—	—
34.0 ...	—	—	—	—	—	—	—
.5 ...	—	—	—	—	—	—	—
35.0 ...	—	—	—	—	—	—	—
.5 ...	—	—	—	—	—	—	—
36.0 ...	—	—	—	—	—	—	—
.5 ...	—	—	—	—	—	—	—
37.0 ...	—	—	—	—	—	—	—
.5 ...	—	—	—	—	—	—	—
Total ‰ ...	999	1000	1000	1000	1000	1000	1000
Number ...	219	347	326	269	327	305	170

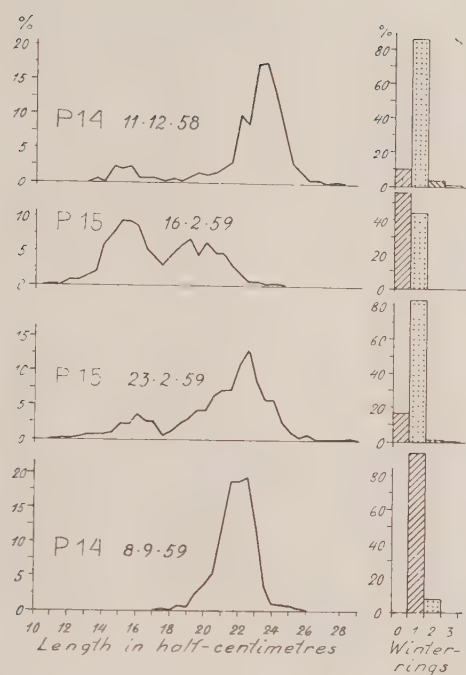


Figure 17. Length and age composition of pelagic trawlsamples from the Skagerak.

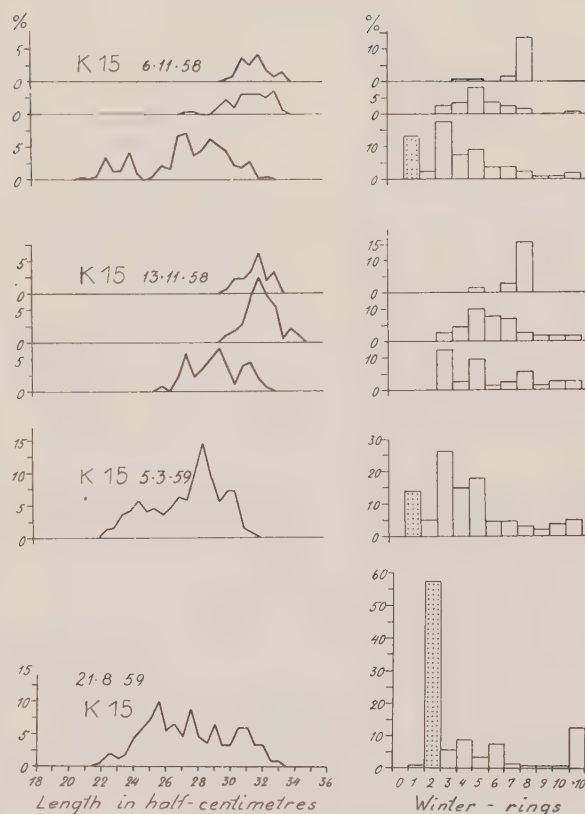


Figure 18. Length and age composition of pelagic trawl samples from the Egersund Bank.

Table 63. Total number of vertebrae (V.S.) in relation to maturity stages, Skagerak

Gear Square Date Stage	Pelagic pair-trawl							
	P 14		P 15		P 15		P 14	
	11. 12. 58		16. 2. 59		23. 2. 59		8. 9. 58	
	No.	V.S.	No.	V.S.	No.	V.S.	No.	V.S.
I	248	56.48	284	56.50	186	56.61	204	56.76
II	10	57.00	6	56.16	11	56.64	3	56.33
III	—	—	4	56.00	3	55.67	1	56.00
IV	—	—	—	—	—	—	—	—
Total	258	56.50	294	56.49	200	56.60	208	56.75

Table 64. Total number of vertebrae (V.S.) in relation to maturity stages, eastern part of northern North Sea

Gear Square Date Stage	Pelagic pair-trawl						Bottom trawl			
	K 15		K 15		K 15		H 17		H 18	
	6. 11. 58		13. 11. 58		5. 3. 59		21. 8. 59		27. 1. 59	
	No.	V.S.	No.	V.S.	No.	V.S.	No.	V.S.	No.	V.S.
I	24	56.84	1	57.00	15	56.87	43	56.91	35	56.48
II	116	56.60	72	56.65	184	56.59	24	56.92	158	56.62
III	13	56.85	2	57.00	1	58.00	34	56.44	—	—
IV	63	57.03	104	56.96	—	—	104	56.44	15	57.20
V	10	57.40	—	—	—	—	4	56.00	—	—
Total	226	56.80	179	56.84	200	56.62	209	56.57	208	56.64

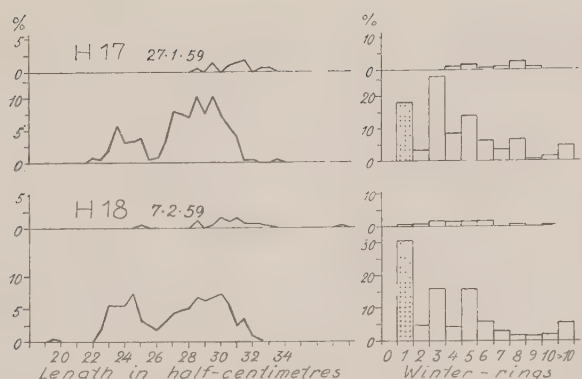


Figure 19. Length and age composition of bottom trawl samples from the Utsira Bank.

close similarities to the Skagerak spring spawners, with regard to vertebral count, L_1 , age composition, and scale type.

The other two Egersund Bank samples consisted of Bank herring without intermixture of spring spawners; the one taken in March 1959 having a similar age composition to those of the Bank herring groups in the two November samples. In the sample from August 1959, however, 2-ringers (1956 year-class) were strongly predominant as was the case in other parts of the northern North Sea in summer 1959.

Utsira Bank. Two samples taken from statistical squares H17 and H18 in January/February consisted of Bank herring with a slight admixture of spring spawners (7% and 9% respectively). These data are given in Tables 62 and 64, and Figure 19. It should be noticed that all spring spawners in the January sample belonged to the Atlanto-Scandinavian tribe, whereas in the February sample only 2 individuals were Norwegian and 22 resembled the Skagerak spring spawning type.

Western and middle part of northern North Sea

Six samples, taken at intervals from late July to late September, were analysed (Tables 62 and 65;

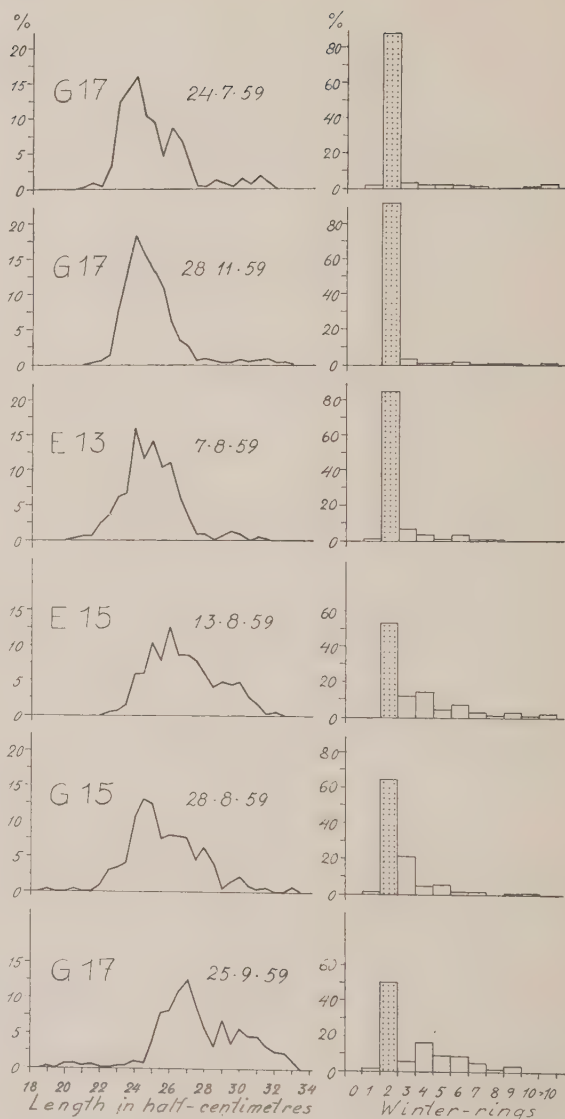


Figure 20. Length and age composition of bottom trawl samples from the western and middle parts of the northern North Sea.

Table 65. Total number of vertebrae (V.S.) in relation to maturity stages, western and middle part of northern North Sea

Gear Square Date Stage	G 17		G 17		E 13		E 15		G 15		G 17	
	24. 7. 59		28. 7. 59		7. 8. 59		13. 8. 59		28. 8. 59		25. 9. 59	
	No.	V.S.	No.	V.S.	No.	V.S.	No.	V.S.	No.	V.S.	No.	V.S.
I	23	56.48	44	56.59	18	56.72	9	57.00	55	56.80	6	57.00
II	43	56.51	35	56.89	9	56.56	21	56.95	32	56.69	144	56.69
III	85	56.52	53	56.45	54	56.48	25	56.56	34	56.56	27	57.14
IV	65	56.43	76	56.46	91	56.49	143	56.56	71	56.62	13	57.00
V	—	—	1	56.00	33	56.54	14	56.50	1	57.00	—	—
VI	—	—	—	—	—	—	—	—	—	—	—	—
VII	—	—	—	—	2	56.50	—	—	4	57.00	2	56.50
VII—II	—	—	—	—	—	—	2	56.50	5	56.20	12	56.43
Total	216	56.49	209	56.56	207	56.52	214	56.61	202	56.67	204	56.75

Table 66. Total number of vertebrae (V.S.) in relation to maturity stages, Kattegat

Gear Square Date Stage	Drift-net	
	Q 13	
	16. 10. 59	
No.	V.S.	
I	—	—
II	8	56.15
III	3	56.67
IV	32	56.19
V	93	56.26
VI	11	56.28
VII	5	56.40
VII-II	15	56.27
Total	167	56.25

Figure 20). The majority of these herring were undoubtedly Bank herring but, as the mean vertebral counts suggest (Table 65) a small number of spring spawners might be contained in the last three samples. It appears clearly from the age composition in Figure 20 that the Swedish herring

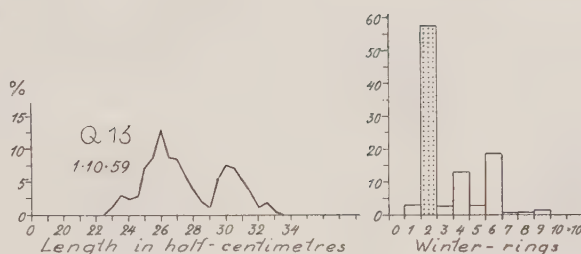


Figure 21. Length and age composition of a drift-net sample from the Kattegat.

fishery in the North Sea in late summer and autumn 1959 was based overwhelmingly on the 1956 year-class of the Bank herring.

The Kattegat

One sample was analysed from a drift-net catch in statistical square Q13. The data are given in Tables 62 and 66, and Figure 21.

HANS HÖGLUND

C. Skagerak, Kattegat, and Baltic-Belt Seas

Young Stages

Environmental Effects on the Survival of Larvae of Baltic Herring in Riga Gulf

(Figure 22; Tables 67-68)

Our studies in recent years (LISIVNENKO, 1957; TOOM, 1958) have established the low mortality rate of salaka during the embryonic stage of development; mortality is highest during the period of transition of larvae to active feeding. The numerical strength of salaka larvae is determined at this stage by the size and composition of the food supply; mainly it is influenced by the number of nauplii and copepods.

The numerical strength of zooplankton is determined by the volume of river discharge in winter and spring, the temperature regime of the Gulf of Riga and by the amount of sunlight (hours of sunshine).

Sunlight is very important for the intensive production of zooplankton and, therefore, for the intensity of feeding of salaka larvae. For the last five years a distinct correlation has been observed between the amount of sunlight and intensity of feeding of the larvae of salaka. This is shown in Table 67.

The most favourable conditions for the larvae occur in the years when the peak of "outburst" in the development of zooplankton coincides with the period of transition of the main part of larvae to active feeding. This had also been noted by NIKOLAËV (1957).

Table 67.

Years	Deviations in intensity of sunlight from normal (%)	% of feeding salaka larvae off the coast of Riga Gulf
1955	+ 17.2	50
1956	— 4.6	40
1957	+ 3.5	46
1958	— 10.0	34.6
1959	+ 10.0	64.2

A point of particular interest, in the feeding of the larvae is that they prefer nauplii and copepods, even when under generally favourable conditions the number of rotifers, for example, far exceeds the number of copepods; in years of low abundance of copepods, rotifers constitute only a part of the larvae's diet. The larvae pass entirely to a rotifer diet when the number of copepods is reduced to such a low value that only one copepod food organism can be found per 100 cubic cm of water.

Larvae of salaka are very numerous in years characterized by warm or moderate winters, intensive river discharge in the first part of the year, good sunlight conditions, and early warming of water in the coastal zone. It is these conditions which account for high numerical strength of food plankton. Similarly, low abundance of larvae occurs in years marked by the opposite characteristics. These conclusions are well illustrated in Table 68.

Another convenient index for practical evaluation of living conditions for salaka larvae (somewhat differently applied by RANNAK (1953) as an index

Table 68. Environmental conditions and the abundance of spring spawning populations of salaka

Years	Total of negative temperatures in winter/Riga-Liepaja	Character of winter	Volume of water (cm ³) per one food organism during transition of larvae to active feeding	Frequency of occurrence of rotifers in food (%)	Character of abundance of year-classes
1953/54 ...	641	Cold	—	—	Poor
1954/55 ...	361	Moderate	38	Close to none	Good
1955/56 ...	640	Cold	184	8	Poor
1956/57 ...	253	Moderate	76	None	Fair
1957/58 ...	431	Cold	125	10	Poor
1958/59 ...	93	Warm	51	None	Good

of their density) is the volume of water in the main area of their habitat per one food organism (copepods, their nauplii, and copepod stages).

A quantitative relationship exists between the number of survived larvae and the abundance of zooplankton (expressed in terms of the above indices) as illustrated in Figure 22.

It is both instructive and interesting that in all years considered the number of zooplankton per larva is approximately the same. This confirms the supposition that the number of larvae is indeed determined by the size of the available food stock.

On the basis of this quantitative relationships and nature of the hydrological and feeding conditions, it seems feasible to make sufficiently accurate preliminary forecasts of the expected abundance of salaka larvae and, consequently, the abundance of year-classes. For example, judging from the

number of larvae of salaka in 1959 (Fig. 22) this year-class is expected to be a good one.

L. N. LISIVNENKO

References

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 Nikolaev, I. I., & Krievs, H. K., 1957. Ibid.
 Rannak, L. A., 1953. Trudy VNIRO, 26.
 Toom, M. M., 1958. Ibid., 34.

Danish Investigations of Young Herring in the Limfjord, Skagerak, Kattegat, Belts, and Baltic in 1959

(Table 69)

A sample of herring, 8—12 cm long, caught in the Limfjord in February (see Table 69) were Limfjord spring and early summer spawners. Their V.S. and K₂ were a little higher than in the Limfjord spring spawning race, which shows that they were mixed with small numbers of North Sea autumn spawners.

Some shoals of young herring, which were found close to the shore of the North Sea coast, at the western entrance to the Limfjord, during a fortnight in July, gave rise to a relatively large fishery. A sample consisting of fish 13—17 cm long showed that they were autumn spawned herring of the year-class 1957. When their racial characters are compared with the V.S.—V.P. and V.S.—K₂ diagrams in Rapp. et Proc. Verb. 143 (2) 1958, pp. 96 to 97, it is seen that they were Dogger Bank herring.

In the eastern Skagerak and the northern Kattegat most of the young herring, 9—17 cm in length belonged to the races spawning in the Gut or perhaps on the Dogger. Their K₂ is a little too low for this racial group, but undoubtedly this character sometimes may be counted a little too low on the small herring. One sample, taken on 13. January from 75 m depth, consisted of Kattegat coastal autumn spawners of the group with the relatively low V.P. From April, only a very small sample was investigated, which consisted of autumn spawners, perhaps of the group which dominated in January/February. However, a sample in June from the Skagerak consisted of juveniles of the large Kattegat winter herring, which are related to the Atlanto-

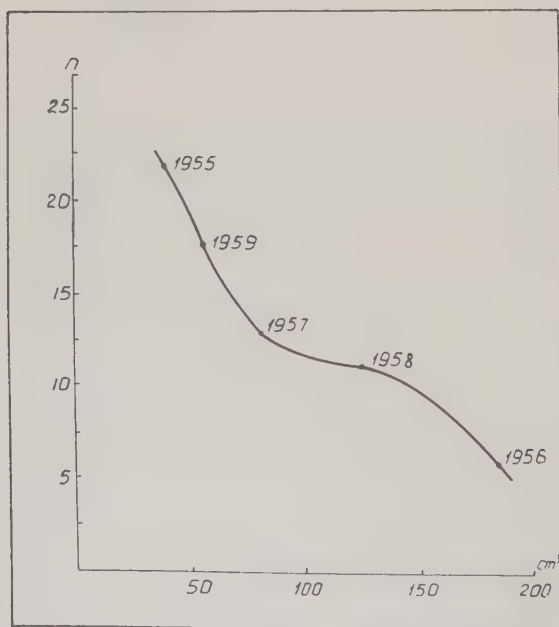


Figure 22. Relation between the number of larvae (caught per 10 min. of sampling) and the abundance of food organisms (cm³ of water for each individual).

Table 69. Young herring from the Limfjord, Skagerak, Kattegat, Belts, and Baltic in 1959

Date	Depth, m	Number of Samples	Mean length, cm	V.S. Mean	V.P. Mean	K ₂ Mean	Number
The Limfjord							
27. February	10	1	8-12	56.03	115	23.75	14.45 102
Off Thyborøn							
6. July	4	1	13-17	56.37	233	23.88	14.74 224
Eastern Skagerak and northern Kattegat							
14. Jan.-26. Feb.	30-113	12	9-17	56.52	1045	24.03	14.39 920
13. January	75	1	9-15	56.03	78	24.10	14.4 10
13. Jan.-23. Feb.	38-175	14	16-25	56.53	551	23.72	14.33 520
8. April	99	1	13-24	56.66	35	23.80	14.5 19
9. June	80	1	13-22	56.81	121	24.24	— —
21.-23. Nov.	25	2	9-18	56.35	187	24.14	14.86 167
15.-23. Nov.	11-25	2	12-17	56.58	102	24.07	14.54 76
16.-23. Nov.	25-92	2	18-25	56.63	178	23.84	14.41 194
Southern Kattegat							
23. Feb.-10. Apr.	25-32	3	12-20	56.17	301	24.06	14.46 223
14. October	32	1	12-17	56.49	188	24.69	14.61 117
Aarhusbay (northern Belts)							
15. Jan.-7. April	13-43	4	10-18	56.13	453	23.86	14.27 408
3. Aug.-26. Oct.	13-25	6	9-17	56.15	693	24.79	14.48 352
Great Belt							
14. January	29	1	10-16	—	—	—	14.18 80
14. January	29	1	16-23	55.89	159	24.43	14.30 152
Little Belt							
27. January	38	1	8-16	55.62	137	23.73	14.11 150
Baltic, off Neksø, Bornholm							
23. March	75	1	10-17	55.61	131	23.60	14.28 106

Scandian winter herring. The V.S. and K₂ of herring, 9—18 cm length, in two samples from November were similar to those in the sample from Thyborøn in July, but the relatively high V.P. may indicate that they were autumn spawners from places off the Jutland west coast, a race which is seldom found. In two other samples the herring were from spawning places in the Gut region.

The herring of 16—25 cm length, fished in January/February were members of the 1956 year-class from the central North Sea (the Gut region). Those of 18—25 cm length, in November, seem to consist of the same race mixed a little with herring of the Atlanto-Scandian type. The V.S. and V.P. might have indicated that they were Downs herring but the low K₂ excludes this race.

In the southern Kattegat, the Kattegat coastal spring spawners were found in samples of herring, 12—30 cm in length, in February—April. A sample of similar size, taken in November, consisted of a mixture of Kobbergrund herring or Kattegat coastal autumn spawners of the type with a very high V.P., mixed with herring of the Atlanto-Scandian type.

The herring in the northern Belt Sea (Aarhus Bay; see Table 69) in January/April had lengths

increasing from about 13—14 cm to 15—16 cm, and they were spring or early summer spawners from the Kattegat and the northern Belt Sea. In August/October the herring of similar length were Kattegat coastal autumn spawners of the type with a high V.P. or mixtures between these and Kobbergrund herring.

In a sample from the Great Belt in January, the herring of about 13 cm were spring spawners, but only their K₂ was investigated while those of about 20 cm were coastal autumn spawners from the Kattegat of the type with a high V.P. The K₂ undoubtedly is counted a little too low.

A sample of herring, 8—16 cm in length from the Little Belt in January consisted mostly of Belt Sea spring spawners, but their length distribution and their relatively high V.P. and K₂ indicate that they were mixed with some autumn spawners. The herring fished E of Bornholm in March had almost the same racial characters. The combination of V.S.—V.P. places them as spring spawners, but their K₂ is higher than found in any sample of spring spawners with this V.S.

AAGE J. C. JENSEN

Table 70.

cm	Length distribution (‰)																			No. invest.
	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30				
Gdansk Region	6	12	40	83	125	146	112	100	106	98	91	48	19	8	4	2	5,877			
Bornholm Basin.....	—	2	10	48	120	189	175	162	116	86	50	22	14	4	2	—	4,890			

Table 71.

Age	Age distribution (‰)												No. invest.
	2	3	4	5	6	7	8	9	10	11	12+		
Year-classes	1958	1957	1956	1955	1954	1953	1952	1951	1950	1949			
Gdansk Region	21	54	35	170	177	112	75	50	81	123	102	600	
Bornholm Basin	8	64	32	301	231	166	54	24	30	42	48	600	

Polish Investigations on Baltic Herring in 1959

(Tables 70-72)

The age and length compositions of spring spawners in catches from the southern Baltic during the summer/autumn feeding period in 1959 are presented in Tables 70 and 71.

These herring, belonging to a stock of the central Baltic, contributed about 70% to the total Polish catches of Baltic herring in 1959.

The most numerous year-classes in both areas were those of 1953, 1954, and 1955. Besides, in the Gdansk region, the rich year-classes of 1948 and 1949 still made a fairly large contribution to the catches.

The catch per fishing day in the summer/autumn season of 1959, when this stock of herring predominated in the landings, increased slightly from its level in 1958. The corresponding figures for the year 1955 to 1959 are given in Table 72.

The local stocks of spring herring spawning in the brackish water of the Gdansk and Pomeranian Bays gave very low catches in 1959. This was similar to the results obtained during the spawning season in the spring of 1957 and 1958.

The landings of autumn spawners in the Bornholm Basin decreased in 1959. The year-classes of 1956, 1954, 1953, and 1952, predominated in the stock fished in this region.

In general, the Polish herring catches in the southern Baltic were on the same level as in 1958, amounting in 1959 to 15,500 tons.

The quality of the spring spawning herring was slightly better than in 1958. The length/weight coefficient (maturity II-III) increased in the Gdansk region from 0.624 in 1958 to 0.639 in 1959 and in the Bornholm Basin from 0.657 in 1958 to 0.671 in 1959.

J. ELWERTOWSKI, H. Janko, J. POPIEL

Preliminary Results of Investigations on Fecundity of Baltic Herring

(Table 73)

In 1959 investigations were conducted on fecundity of spring and autumn spawning herring. So far, the fecundity of 78 female specimens, in gonad stage V, have been analysed, 53 spring spawners and 25 autumn spawners.

Each fish was first measured and weighed, whereupon the whole gonads were weighed and two samples of each taken, weighed, and the number of eggs counted. The fecundity of herring for different length groups was then determined. Table 73 shows the initial results of this analysis.

These data indicate that the autumn spawning herring are much more fecund than the spring spawners. The gonads of the autumn herring contained two or three times the number of eggs of the spring spawning specimens in almost all length groups. This is in conformity with the observations of other workers.

K. STRYZEWSKA

Table 73.

Table 72.			Length in cm	Number of eggs, spring spawners	Number of eggs, autumn spawners
Year	Gdansk Region	Bornholm Basin			
1955	200 kg/fishing day	944 kg/fishing day	19	17,039	28,856
1956	478	786	20	20,482	39,139
1957	85	688	21	21,368	43,375
1958	243	621	22	30,977	50,487
1959	278	662	23	31,705	80,707
			24	32,952	77,983
			25	33,808	80,945
			26	35,557	91,148
			27	48,791	97,344
			28	54,672	131,158

Sardine

Sardine

Sardine entre Loire et Gironde en 1959

(Figure 1; Tableaux 1-2)

De mai à octobre 1959, 1.400 sardines, provenant de pêches faites entre Loire et Gironde, ont été examinées au laboratoire de La Rochelle.

Sur ce matériel nous avons noté en mai-juin la présence habituelle de sardines du Gr. I de type armoricain, à moyenne vertébrale élevée (52,54 et 52,62) et de taille modale comprise entre 130 et 145 mm.

Ces sardines ont disparu au début de juillet et nous n'avons plus trouvé sur les pêcheries qu'une population du Gr. 0, de type cantabrique caractérisée par sa basse moyenne vertébrale (51,61 à 51,71), et dont nous avons pu suivre la croissance

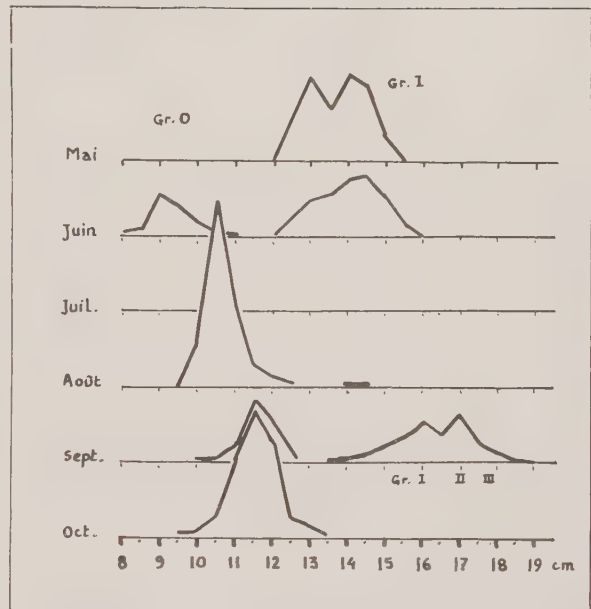


Figure 1. Sardine 1959. La Rochelle.

Tableau 1. Tailles observées

mm	Mai	Juin	Août	Sept.	Oct.
80	—	1	—	—	—
85	—	1	—	—	—
90	—	11	—	—	—
95	—	8	1	—	1
100	—	4	12	1	1
105	—	1	51	1	6
110	—	1	23	5	21
115	—	—	6	18	36
120	1	1	3	12	26
125	12	5	2	3	5
130	22	10	—	—	3
135	14	11	—	1	1
140	22	15	1	1	—
145	20	16	1	2	—
150	7	11	—	4	—
155	1	3	—	7	—
160	—	1	—	11	—
165	—	—	—	8	—
170	1	—	—	14	—
175	—	—	—	6	—
180	—	—	—	3	—
185	—	—	—	1	—
190	—	—	—	1	—
195	—	—	—	—	—
200	—	—	—	1	—
Nombre	350	297	172	290	287
Taille à L_1 (mm)	98	90	—	91	—

entre les tailles modales de 90 à 115 mm.

Ce n'est qu'en septembre que nous avons retrouvé des individus de grande taille appartenant aux Gr. I à III du type armoricain. Les Gr. I et II de ces sardines étaient les plus abondants; leurs tailles modales étaient de 160 et 170 mm et leurs moyennes vertébrales de 52,48 et 52,17.

Les sardines du type aquitainien n'ont pas été décelées et la valeur de L_1 est, de ce fait, restée élevée durant toute la saison de pêche (90 à 98 mm en moyenne).

Par suite de cette composition du stock, si la pêche a été bonne au printemps, elle a été pratiquement nulle en été, les sardines du Gr. 0 ayant une taille trop faible pour être commercialisées. Elle n'est redevenue satisfaisante que dans le courant de septembre grâce à l'apport des Gr. I à III.

R. LETACONNOUX

Tableau 2. Moyenne vertébrale

	Mai	Juin		Août	Septembre			Octobre
Gr.	I	0	I	0	0	I	II	0
50	—	1	—	2	4	6	—	4
51	4	42	4	37	32	46	21	42
52	44	52	40	55	53	42	45	41
53	46	5	47	6	11	6	30	12
54	6	—	8	—	—	—	4	1
55	8	—	1	—	—	—	—	—
Moyenne	52,54	51,61	52,62	51,65	51,71	52,48	52,17	51,64

Sprat

Tagging Experiments on Sprat in Norwegian Waters

As mentioned in the report of 1958 external tagging experiments on sprat were carried out for the first time in Norway that year.

The results obtained were used during the fishing season of 1959. In the last days of May, 175 tagged sprats were liberated at Mosnes in the Aakrefjord on the west coast of Norway. At the end of August 2 of these were recaptured about 20 nautical miles further out the fjord, after 100 days at liberty.

Later in the summer from 30. July to 26. September 722 tagged sprats were liberated in small shoals with varying intervals at Norheimsund and Framnes in the Hardangerfjord.

Of these 16 were recaptured in the neighbourhood of the tagging locality, while 7 were recaptured at Folkedal and at Kinsarvik about 15 nautical miles further inside the fjord. The days at liberty varied between 3 and 69 days.

In connexion with the external tagging, a modified internal tagging method for herring was tried on sprat. As most of the sprat caught in Norwegian waters are intended for canning it is very important that a tagged fish is easily visible at the factory.

A small hole was made in the middle of an internal tag for sprat and a piece of nylon gut No. 15 melted to a knot in one end was pulled through the hole until stopped by the tag. The tag was then placed into the belly of the fish with the "knotless" end of the gut hanging out of the wound. The method was tested on tags of steel and plastic and the equipment during tagging was three different dip-nets and the "tagging-slucice" (see AASEN, Ann. Biol., 10: 148. 1953) modified for sprat.

After having made a small incision into the body wall, the tag is inserted into the body cavity with the right hand while the left hand holds the "knotless" end of the gut. By pulling the gut the tag will slide backwards into the body cavity until the hole in the tag with the gut is opposite the wound.

After having kept the fish for four weeks in captivity in a live net the survival percentages for the different equipments were as follows: the "tagging-slucice", 83%; dip-net lined with wash-leather, 60%; dip-net lined with foam rubber, 35%; and dip-net lined with sack-cloth, 15%.

For sprat tagged with tags without gut the survival percentage was 96% in the "tagging-slucice" and 86% in the dip-net lined with sack-

cloth. The tags with gut are probably more difficult to insert into the sprat without damaging the fish. In sprat tagged with tag only, the wound was completely healed after four weeks and no harm seemed to be done to the fish.

In about 50% of the sprat wearing tags with gut hanging out the wound was healed, in the other 50% the wound was open but quite small, and at the end of the experiment no ill-effects on the survivors seemed to have occurred. During captivity the sprat were fed with preserved cod roe. They seemed to appreciate the food, and an analysis of the stomach content showed that the majority of the stomachs were filled with cod roe.

By using gut in strong colours it would be possible to find the tagged sprat at the canneries. The advantage of this method in comparison with the external tagging method is the greater security that the tag will not fall off after some time.

KAARE GUNDERSEN

Polish Investigations on North Sea Sprat in the Summer of 1959

(Table 3)

During the voyages of the Polish research vessel "Birkut" in August/October 1959, investigations on the length, weight, age, and sexual maturity of the sprat were carried out. These sprat were occasionally caught by the trawl, together with the herring.

The investigations were carried out in the Farn Deep and East Bank areas, as well as in the waters north and north-west of Dogger Bank. In the 73 hauls made in this area sprat occurred in 45, five of these containing more than 100 kg of this species. However, these data are not sufficient to establish the exact locality and density of the sprat shoals in the middle part of the North Sea, because the fishery was carried out in the same way as with commercial trawlers. The areas with the largest concentrations of herring were particularly preferred and special effort was made to avoid catching too many other species. The length and age compositions of the sprat caught are shown in Table 3. All the fish in the samples were in maturity stage II. The stomachs contained considerable amounts of food. The fat content of the salted fish caught in October was 23.36%.

J. ELWERTOWSKI

Table 3. Length and age composition of the sprat caught in the North Sea in 1959

Length composition of catches	Number of fish	Age/length key year-classes								Coefficients	Age composition of catches year-classes						Total
		aged	1958	1957	1956	1955	1954	1953	1958		1957	1956	1955	1954	1953		
Length cm	Frequency in ‰																
11	—	2	2	—	—	—	—	—	—	—	—	—	—	—	—	—	
12	4	15	5	5	5	—	—	—	0.26	2	1	1	—	—	—	4	
13	102	39	—	8	29	1	1	—	2.61	—	20	76	3	3	—	102	
14	407	45	—	11	32	1	1	—	9.04	—	99	290	9	9	—	407	
15	451	49	—	7	37	3	2	—	9.20	—	64	341	28	18	—	451	
16	35	25	—	1	11	7	5	1	1.40	—	1	16	10	7	1	35	
17	1	2	—	—	—	—	2	—	0.50	—	—	—	—	1	—	1	
Total	1,000	197							Frequency in ‰	2	185	724	50	38	1	1,000	
Number of samples 10, of fish 1,414																	

Number
of samples 10,
of fish 1,414

Winter Fishery on Sprat in Coastal Waters of Niedersachsen 1958/59

(Tables 4-5)

During the 1958/59 fishing season (October 1958 to March 1959) 99.7 metric tons of sprat, together with 652.8 tons of juvenile herring were caught by fishing boats of the coastal fishery of Niedersachsen. This winter fishery dates back more than 40 years.

Table 4. Length distribution (‰) of sprat

cm	5	6	7	8	9	10	11	12	13	14
Jan.-Mar. 1959	2	16	131	428	149	56	104	82	31	1

Table 5. Fat content of sprat

No.	Date, 1959	Length, cm	Weight, g	Fat content, %
1	13. February	8.9	4.3	9.5
2	13. February	9.5	5.3	5.6
3	13. February	11.4	12.5	17.7
4	13. February	13.8	21.0	13.8
5	19. February	12.2	14.6	11.1
6	19. February	13.5	18.4	11.1
7	19. February	14.0	20.8	14.1
8	19. February	14.0	19.2	9.4
9	16. March	7.9	2.9	4.7
10	16. March	11.6	11.5	15.3
11	16. March	11.8	11.5	16.8
12	16. March	12.7	12.1	6.6
13	16. March	12.8	13.8	15.7
14	16. March	13.5	15.2	10.4

The length composition of 5 samples of 862 sprat, taken between 30. January and 20. March 1959 is given in Table 4, the fat content of 14 fish in Table 5. The number of sprat caught by this fishery during the 1958/59 season was estimated at some 19 millions.

KLAUS TIEWS

Danish Catches of Sprat from the North Sea, Limfjord, Skagerak, Kattegat, Belts, and Baltic in 1959

(Table 6)

Eggs and larvae

Fishing for eggs and larvae was carried out in the eastern Skagerak and the northern Kattegat in June and July from "Havkatten" and "Biologen" as in 1958, in cooperation with Norway and Sweden. As yet only a part of the Danish samples has been analysed. Eggs were found in the eastern part of the northern Kattegat and at some stations in the Skagerak. In the samples from 1958, eggs were found in relatively large quantities off Arendal (where no Danish stations were occupied in 1959).

Length distribution, age, and abundance

On the North Sea coast of Jutland sprat were caught by trawl and seine during the summer, and the lengths of some samples are shown in Table 6. It is seen that they were of the 1958 year-class and of normal length. A sample from the small by-catch of sprat in the herring fishery off Esbjerg in November (see Table 6) shows that most of the sprat were of the same year-class with one ring, some few of year-class 1959. The length of the 1¹/₂ year-old sprat was remarkably low, but according to the information obtained, no larger sprat were sorted from the sample. Four of the samples have been placed at my disposal by Mr. POPP MADSEN.

The Limfjord samples from catches in February and April were composed of equal parts of the 1958 and 1957 year-classes. In the catches, 17 and 46% respectively of the weight was sprat, which is about the normal relative frequency in this area.

In the eastern Skagerak and northern Kattegat the 1958 year-class was predominant in the samples, and older and larger fish were relatively few. The

Table 6. Length composition of sprat (%) in Danish samples in 1959 (total length to centimetre below), and racial characters
(n = number examined)

Date	North Sea			Limfjord	E Skagerak—N		Kattegat		S Kattegat	
	Jutland coast	Off Thyborøn	WSW of Esbjerg		1. quart.	2. quart.	Sorted (for conserv.)		Sorted (for conserv.)	
Depth, m	6/7—9/8	14/8	25/11	27/2—28/4	33—89	38—99	4. quart.	23/2—10/4	29/10	
cm	4	4	20	10—11			20—113	25		
6	—	—	—	—	1	—	—	—	—	—
7	—	—	—	1	8	—	1	—	—	—
8	—	—	2	35	28	—	5	—	1	—
9	8	1	4	17	41	3	4	—	11	—
10	45	21	45	1	13	25	12	—	40	2
11	30	47	44	17	2	49	10	4	21	3
12	12	20	6	25	2	11	17	27	8	7
13	4	6	—	4	3	4	44	58	10	28
14	1	2	—	—	1	2	8	12	6	50
15	—	2	—	—	1	3	—	—	2	9
16	—	—	—	—	1	2	—	—	—	—
17	—	—	—	—	—	1	—	—	—	—
Total	100	99	101	100	101	100	101	101	99	100
Number measured	137	81	51	321	1,142	1,559	333	647	1,934	391
V.S.	47.51	47.82	47.30	47.40	47.96	47.99	47.92	47.93	47.85	47.80
n	123	80	46	491	845	382	332	582	1,407	326
K ₂	11.58	11.84	11.64	11.55	11.83	11.75	11.86	11.97	11.68	11.93
n	130	74	42	206	753	72	335	610	659	368

Date	Great Belt		Belts				W Baltic		Central Baltic	
			Aarhus Bay				Little Belt	S of Langeland	E of Neksø	W of Rønne
Depth, m	14/1	20/10	1. quart.	2. quart.	3. quart.	4. quart.	27/1	20/7	23/3	24/4
cm	29	15	25—42	13	14—16	12—25	38	31	75	35
5	—	1	—	—	—	1	—	—	—	—
6	—	4	1	—	1	1	1	—	—	—
7	1	11	1	—	1	3	3	—	—	—
8	1	40	4	—	1	8	18	—	4	—
9	1	40	41	4	1	14	46	4	2	—
10	5	4	45	24	2	10	29	18	12	3
11	6	larger	7	24	10	4	1	47	37	3
12	33	for	1	21	32	20	1	19	28	36
13	39	consump.	—	16	46	35	1	5	14	54
14	14	not	—	8	6	5	—	5	2	5
15	1	invest.	—	4	—	—	—	2	—	—
Total	102	100	100	101	100	101	100	100	99	101
Number measured	346	621	341	275	867	1,132	360	57	47	67
V.S.	47.73	47.86	47.78	47.86	47.85	47.83	47.81	47.84	48.02	47.93
n	196	539	300	22	1,143	943	161	56	41	56
K ₂	11.81	11.77	11.64	11.91	11.66	11.81	11.70	11.76	11.25	11.63
n	200	48	291	22	367	837	165	51	40	24

sprat constituted a higher percentage of the catches than in 1957 and 1958, when they were extremely scarce. In the catches of herring for processing (50—100% of the total catch), the sprat constituted on an average 12% by weight in the first half of the year, and in November about 40% of the total

catch in the two samples investigated from this fishery. The stock has improved on account of the good 1958 year-class, especially in the autumn but the total Danish commercial catch in 1959 was still far below the normal. In autumn the 1959 year-class appeared in the catches. It constituted about

15% by number in the samples investigated but in the spring of 1960 they were found in relatively larger quantities.

Also in the southern Kattegat and in the Belts and western Baltic the 1958 year-class dominated the catches; older year-classes constituted, however, a relatively large part of the catch. In the fourth quarter of the year about a third of the samples of sprat from Aarhusbay were of the 1959 year-class. In the central Baltic at Bornholm the year-classes 1957 and partly also 1956 dominated the catches.

Racial investigations

Four of the samples from the south-eastern North Sea and those from the Limfjord had the same racial characters as a race-group formerly known from these areas (see Table 6). This group has a V. S. about 47.3—47.7 and K_2 about 11.4—11.6. One sample taken on the coast near Thyborøn on 14. August had the same characters as a sample from the Bløden Ground in February 1958 (see Ann. Biol. 15: 191), and both were at the limit of the race-group found in the south-eastern Skagerak and northern Kattegat where the V.S. of the samples varies between 47.85 and 48.10 and the K_2 between 11.6 and 12.0. The V.S. of the sample from Thyborøn was distinctly higher than the other race-groups found in some samples from 1952, 1955, and 1958 from the south-eastern North Sea. It seems that a race-group with the V.S. and K_2 as those in the eastern Skagerak and northern Kattegat is relatively rarely encountered in the North Sea, and so far it seems to be excluded that there is very much interchange between the stocks of sprat in these two areas.

On the other hand, most of the samples from the south-eastern North Sea including all those from 1959 had the same V.S. as found in some of the samples from the west coast of Norway and a considerable interchange between these two areas (transport of eggs and larvae, possibly also of young sprat from the North Sea to the Norwegian coast) therefore is probable. It is regrettable that no value for K_2 of the Norwegian sprat is known. Naturally the (yet unknown) K_2 of these sprat may prove that they cannot belong to any of the North Sea race-groups but possibly it may show that they are identical with one or more of the North Sea groups.

The samples from the eastern Skagerak and the Kattegat had the racial characters which are characteristic for this area and, as usual, the variation from one sample to another was very small. The V.S. varied between 47.85 in a sample

of 111 fish and 48.16 in a sample of 49 fish. The relatively high vertebral count, which was characteristic for most of the 1958 samples was found in 1959 in a few only. It may seem that the "foreign" sprat had disappeared again. The K_2 varied between 11.59 (17 fish) and 12.03 (36 fish).

In February/April the sprat in the southern Kattegat had V.S. and K_2 intermediate between those of the eastern Skagerak and northern Kattegat and the Belts. The sprat of 12—15 cm length in a sample from February and the large sprat in a sample from October had a very high K_2 of 11.9 which was also found in some samples from this area in some previous years, and in the northern Belts in a few samples from previous years, and in most of the samples from 1959.

In a few samples from the western Baltic and the Little Belt the V.S. and K_2 were identical. One of the samples from near Bornholm had a V.S. at the lower limit for the low K_2 , which is characteristic for the Baltic, but the K_2 may seem to be at the higher limit for this race-group.

The variations of the racial characters

The validity of the numerical racial characters for a determination of the origin of the sprat in a certain sample has been doubted because it has been found that the smaller sprat in some samples from the Norwegian coast have a lower V.S. than the larger ones, and also because it has been suspected that the variation in these characters from one year-class to another may be very great. The Danish material from 1959, and partly also from previous years, presents a preliminary answer to this doubt.

In two samples from the North Sea mainly consisting of the year-class 1958 the V.S. and K_2 were as follows (number in brackets):—

	Off Ringkøbingfjord 9/8 1959		At Thyborøn 14/8 1959	
	V.S.	K_2	V.S.	K_2
Small	47.38 (56)	11.64 (58)	47.87 (38)	11.93 (29)
Large	47.68 (31)	11.55 (31)	47.77 (40)	11.78 (45)

The sprat in the first sample was divided at 110 mm, those in the second at 115 mm.

In the Skagerak, northern Kattegat, and the Limfjord the V.S. and K_2 in 1959 were as follows:—

Length, mm	N of the Scaw, 9/6	E of Frederikshavn, 20/11		Limfjord, 28/4
	V.S.	V.S.	K_2	V.S.
<110	47.95 (92)	47.88 (67)	11.87 (54)	47.43 (191)
110—119	47.96 (166)	48.12 (33)	11.97 (32)	47.33 (89)
120—129	48.10 (30)	47.95 (20)	11.78 (50)	47.50 (102)
130—149	48.10 (9)	47.90 (155)	11.88 (154)	— —

In the samples from N of the Scaw the sprat less than 13 cm were almost exclusively one year-old. In the sample from E of Frederikshavn the sprat of less than 12 cm were of the 1959 year-class mixed with the 1958 year-class, the larger ones mostly of the 1958 year-class, and those over 13 cm were nearly only this year-class. In the Limfjord sample the sprat below 11 cm were almost pure 1 year-old and those over 11 cm were pure 2 year-old sprat.

Here are shown 2 samples which exhibit the largest difference in the racial characters of the small and large sprat of a year-class in the Danish material from these areas, and 3 samples which show no difference. In some samples the smaller ones in a year-class show higher values than the larger ones, and if we take the mean of all samples from a season no difference is found between the V.S. and K_2 of the various lengths or ages, or a difference of only 0.1 in each of these characters.

It is seen that a difference in V.S. or K_2 in smaller and larger sprat of a year-class is not a normal feature for all areas. In some samples from the North Sea and the eastern Skagerak the V.S. and K_2 may be a little lower than in the larger ones, but this difference here is so small that it has no effect for the use of these characters for establishing the belonging of the sprat of a sample to a well defined race-group specific to a certain area. If a great difference occurs in a sample of one year-class, the first hypothesis may be that the sample is a mixture of two different race-groups. It is well known that shoals of sprat may sometimes divide or melt together with another shoal.

It seems to be certain from the material published in this and former volumes of the Ann. Biol. that the V.S. and K_2 may vary a little from one year-class to another although mostly it is remarkably

constant, as, for example, in the above mentioned samples from E of Frederikshavn and the Limfjord. Neither does this variation destroy the separation between the different race-groups.

AAGE J. C. JENSEN

Polish Investigations on Sprat in the Southern Baltic in 1959

(Tables 7-8)

The dynamics of the Polish sprat catches in recent years in the different areas of the southern Baltic is shown in Table 7.

In 1959 the yield of the sprat catches in Gdansk Bay decreased, whereas it increased extraordinarily in the Slupsk Furrow and Bornholm area. The total catches of the Polish sprat fishery in the Baltic were much higher in 1959 than in previous years. The difference in the yield obtained in the different areas was attributed rather to the fluctuations in the availability of the fish than to the fishing intensity which increased on the fishing grounds in the open sea (mainly in the Slupsk Furrow).

From Table 8 it is evident that during the first part of 1959 the 1955 year-class was predominant in the catches taken in Gdansk Bay, the Slupsk Furrow, and the Bornholm area. At the same time, the 1957 year-class provided a great part of the catches. This latter year-class is regarded as abundant, especially in the eastern part of the southern Baltic (i.e., in Gdansk Bay).

Table 7. Polish sprat catches (tons) in the different areas of the southern Baltic in the years 1957/58/59

Area	1957	1958	1959
Gdansk Bay	2,722.2	9,635.8	7,171.4
Klaipeda area . . .	3.6	71.6	93.4
Slupsk Furrow . . .	97.1	135.9	3,579.8
Bornholm area . . .	524.8	597.7	2,759.6
Other areas	32.7	27.9	314.0
Total	3,380.4	10,468.9	13,918.2

Table 8. Age composition (%/100) of the Polish sprat catches taken in the different areas of the southern Baltic in 1959

Area	A. Winter (Jan./March)		B. Spring-Summer (Apr./July)			C. Autum Gdansk Bay
	Gdansk Bay	Gdansk Bay	Slupsk Furrow	Bornholm area (south)		
Year-class						
1958	14	2	13	19		88
1957	425	441	147	193		87
1956	45	55	57	83		518
1955	477	494	689	597		102
1954	37	7	88	92		197
1953	2	1	6	16		8
Total	1,000	1,000	1,000	1,000		1,000
Yield (kg per day)	490	380	847	440		192

In the autumn of 1959 a large amount of sprat of 6—9 cm length was observed in the catches in Gdansk Bay. These unmarketable fish were hatched during the first part of the 1959 spawning season. They represent a rather abundant year-class in the eastern part of the southern Baltic.

The average temperature of the water throughout the feeding period (August/October 1959) was 16.5°C (15.6°C in the same period in 1958). In the summer of 1959 the ecological conditions for growth and fattening were favourable.

In Gdansk Bay the following increases in length (cm) of the sprat were observed:—

	1959	1958
L ₂	2.9	2.6
L ₃	0.9	0.7
L ₄	0.1	0.5
L ₅	0.3	0.2

In the autumn of 1959 the maximum fat content was 17.05% as against 16.2% in 1958.

J. ELWERTOWSKI, H. JANKO

Scombriform Fish

Mackerel

Mackerel Fishery in the Netherlands in 1959

(Figures 1-4; Tables 1-2)

The methods for collecting data concerning catch, area of fishing, and numbers of fishing hours have not been changed in the year 1959.

The length and age composition of the catch was determined by market sampling and market measurements. As for 1958, the North Sea has been subdivided into five fishing areas (see Ann. Biol., 15: 196, Fig. 3).

The fisheries

The total catch amounted to 15,700 tons (1958: 12,660 tons). This increase in the total catch was mainly due to a successful fishery in the NN area, where both the density (measured as catch per unit

Table 1. Total catch (tons) of mackerel taken per area in each quarter of the year 1959

1959	NN	NE	NW	South	Total
1. quarter	316.1	231.4	—	—	547.5
2. quarter	2,575.5	4,719.4	254.6	1,018.5	8,568.0
3. quarter	1,007.1	1,824.9	784.7	792.4	4,409.1
4. quarter	1,121.3	779.0	197.0	82.8	2,180.1
Total ...	5,020.0	7,554.7	1,236.3	1,893.7	15,704.7

effort), and the effort were significantly higher than in 1958, especially during the peak of fishing in April and May.

As usual, the fishery shifted from the NN to the NE area in April/May and shifted then over to the NW area for the herring fishery on the Fladen. In September/October the fishery took place partly in the NN and NE areas and was partly operated in the southern areas on spawning herring. The main fishery for mackerel took place in April/May and

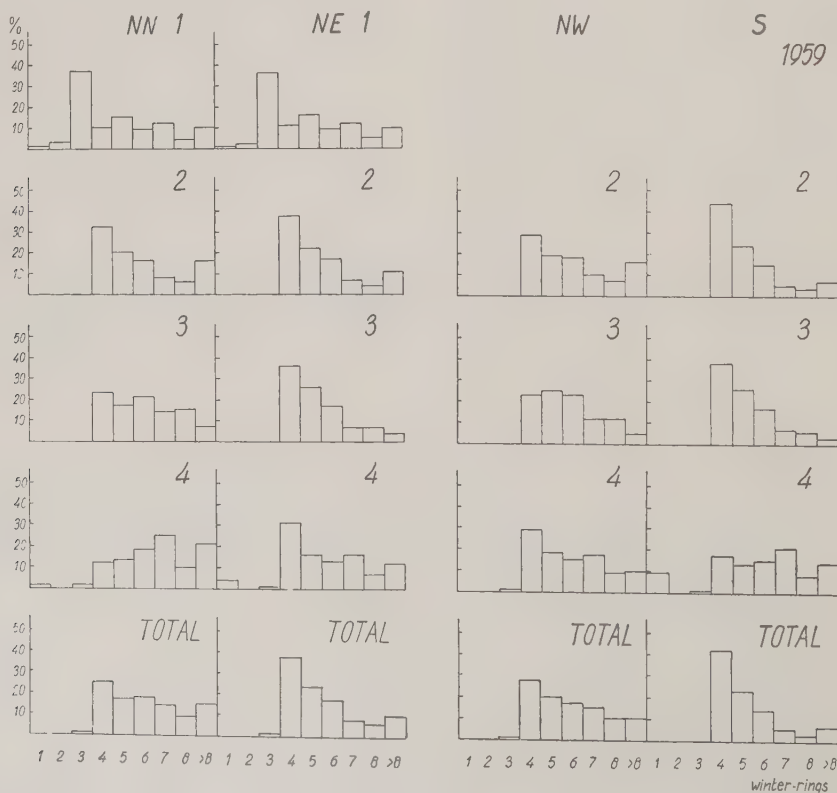


Figure 1. Age composition (winter-rings) of mackerel in the four areas broken down to three-months' periods.

Table 2. Length composition of the catch taken in the different areas during the quarters of the year
(Measurements to the nearest cm)

length, cm	NN				NE				NW			South			Total			
	1	2	3	4	1	2	3	4	2	3	4	2	3	4	NN	NE	NW	South
25	—	—	—	—	—	—	—	0.5	—	—	—	—	—	—	—	0.5	—	—
26	—	0.2	—	—	—	—	—	1.2	—	—	—	—	0.4	2.2	0.1	0.1	—	0.1
27	0.2	0.1	—	—	—	0.1	—	0.4	—	—	—	—	0.7	3.3	0.1	0.1	—	0.2
28	0.3	0.1	—	—	—	0.3	0.1	0.4	0.3	—	—	—	0.4	2.0	0.1	0.2	—	0.5
29	4.6	2.0	0.4	—	2.6	2.6	0.3	0.6	1.1	—	—	3.0	0.3	0.3	1.4	1.9	0.1	2.6
30	10.6	11.8	1.9	0.2	9.7	13.8	1.9	0.8	5.8	0.2	—	14.9	1.9	0.1	6.9	10.4	0.5	12.8
31	10.6	19.5	4.6	0.4	9.8	20.0	19.9	5.8	18.6	5.3	2.6	28.2	14.2	1.6	11.3	16.9	4.1	25.6
32	6.2	13.6	7.7	1.7	5.9	13.7	22.5	12.8	9.8	12.5	8.7	18.4	23.2	4.5	7.8	15.3	9.7	18.7
33	4.4	6.6	5.3	3.7	5.1	8.6	15.1	15.8	7.9	10.6	14.8	3.8	12.4	8.1	5.6	9.8	13.2	5.1
34	7.6	6.7	9.6	6.1	8.5	7.6	10.6	11.6	10.5	12.0	17.4	7.3	10.2	8.4	7.5	8.5	15.5	7.7
35	11.4	8.9	7.3	10.5	14.2	11.3	10.6	11.5	7.9	16.7	24.3	8.1	12.5	12.8	9.3	11.2	21.1	8.9
36	17.0	10.4	14.3	18.7	18.5	10.9	12.3	16.7	16.8	20.3	21.8	77.7	12.9	13.4	13.8	11.7	21.0	8.6
37	13.7	8.8	23.5	23.4	13.3	5.6	10.0	13.2	9.8	15.0	7.8	6.4	8.2	14.3	15.3	7.1	9.7	6.9
38	6.2	4.8	9.9	14.7	5.5	2.1	3.7	5.2	5.1	5.9	2.6	1.3	2.1	10.1	8.3	2.7	3.6	1.7
39	2.7	4.1	6.3	8.4	2.5	1.7	1.1	1.1	3.3	1.2	—	—	0.5	6.3	5.5	1.6	0.6	0.3
40	2.3	2.1	6.0	6.6	1.4	0.7	0.4	0.9	0.4	0.2	—	—	—	4.0	4.1	0.7	0.1	0.1
41	0.8	1.8	5.6	2.4	1.2	0.7	0.1	0.6	0.5	—	—	—	—	3.1	2.9	0.6	0.1	0.1
42	0.7	0.7	0.3	1.4	1.0	0.5	0.1	0.3	0.3	—	—	—	—	3.0	0.8	0.5	—	0.1
43	0.5	0.4	0.1	0.5	0.7	—	0.1	0.2	—	—	—	—	—	1.3	0.4	0.1	—	—
44	0.2	0.1	—	0.5	0.1	—	0.1	0.1	—	—	—	—	—	0.5	0.1	—	—	—
45	—	—	—	0.3	—	—	—	0.1	—	—	—	—	—	0.5	0.1	—	—	—
46	—	—	—	0.2	—	—	—	—	—	—	—	—	—	0.4	—	—	—	—
47	—	—	—	0.2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
48	—	—	—	0.2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
49	—	—	—	0.1	—	—	—	—	—	—	—	—	—	—	35.6	33.2	34.4	32.6

August/September in the NN and NE areas. June, August, and July are the months for mackerel fishing in the Dogger Bank area.

The density distribution in the four areas, indicated by the catch per unit effort, followed in the course of the year approximately the same pattern as in the preceding year. In the NN area the mackerel density in April/May was higher than in 1958, but in the autumn it was lower.

In the NE area the April maximum, so characteristic in 1958, was absent in 1959, but the densities in May and June were in 1959 much higher, whereas the autumn densities were similar to those observed in 1958.

The catch per unit effort in the NW area is probably an unreliable indicator for density, since the main fishery in this area is a herring fishery. The high densities in April/May and September were observed at a time of comparatively low fishing effort on grounds bordering the NE area.

The length and age compositions

The age readings are based on the otoliths. Since it is our impression that these otolith readings are not so reliable as otolith readings in herring, it seemed reasonable to show the length composition of the catch in the different areas per quarter of the year, together with the age composition (see Table 2). It should be mentioned that to be able to compare in Figure 1 the age composition of the first

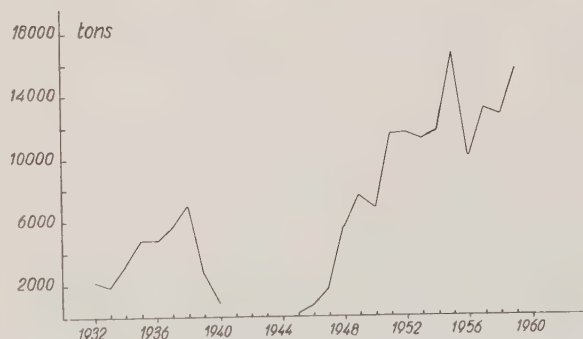


Figure 2. Total landings (tons) of mackerel in Dutch fishing ports, since 1932.

quarter of the year with that in the three other quarters one has to add one year to the age of the fish of the first quarter (arbitrary birthdate: 1st April).

When examining the length composition of the catch in the different areas the following facts are observed:—

The percentage in the landings of fish below 29 cm is very small indeed in 1959.

Two size groups of fish predominated: early in 1959 the first group comprises fish of 30–31 cm length and the second group those of 35–37 cm; taking their growth into account these two groups can be traced practically in all areas and seasons.

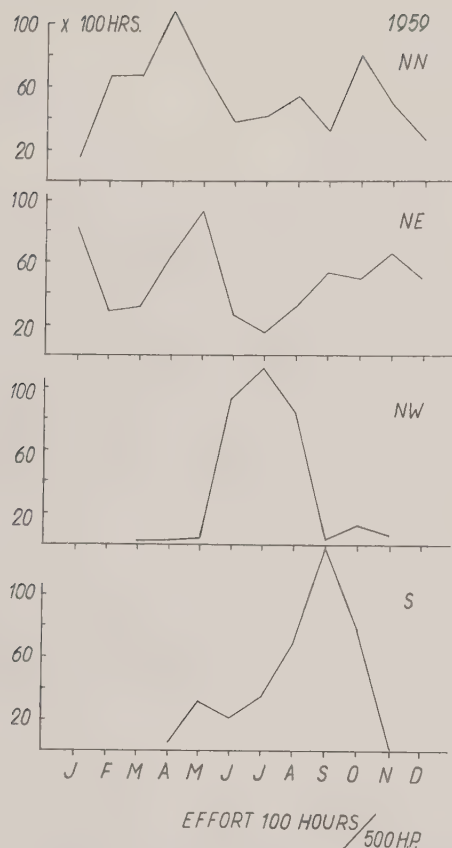


Figure 3. Fishing effort per area in 1959, expressed in 100 hours' fishing by a 500 h.p. standard motor trawler.

The age distribution of the landings in the different areas for the entire year shows that the 2- and 3-ringers were nearly absent. The four-ringers, however, were predominant in all areas. In the areas NE and S the mean age seems to be below that in areas NN and NW; this can also be deduced from Table 2: the mean length in the NN and NW areas is greater than in the NE and S areas.

Migration

The data for density, age, and length of the mackerel in the different areas in the course of the year suggest the following tentative migration pattern for the area in which the Dutch boats are operating.

Hibernation of the mackerel in the areas NN and NE in deep water and along the Norwegian Deep in January, February, and March. The increase of the catches in April in the areas NN and NE, and the appearance of mackerel in the areas NW

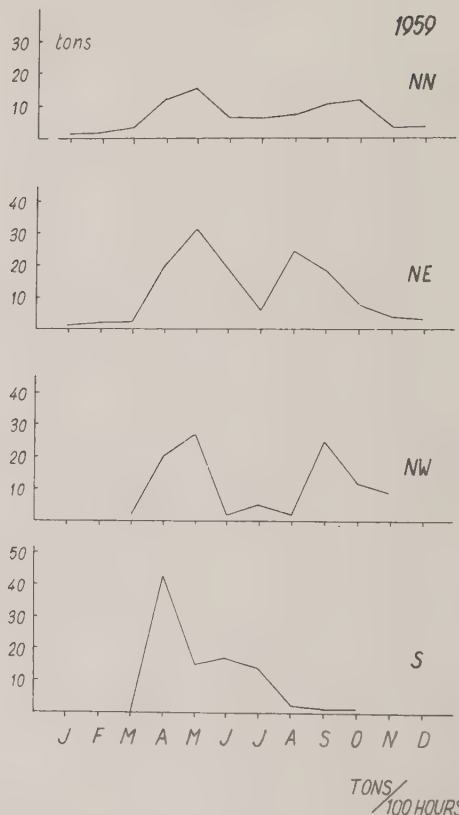


Figure 4. The catch in tons per 100 hours' fishing by a 500 h.p. standard motor trawler in four areas during 1959.

and S, denote the start of the spring migration. Following the density data in the different areas, the migrating shoals of mackerel can be observed to appear first in April/May in the NN and NE areas, and disperse from these areas to the areas NW and S. Simultaneous with the increase in density in the areas NW and South, that of areas NN and NE is declining. In June, July, and August the mackerels are spread over the whole North Sea, and the density in the area South has then reached its peak values.

The migration in the reverse direction is manifested by rising densities in the NE and NN areas whereas, at that time, the density in the southern areas is dropping.

The length and age compositions suggest that the older age-groups tend to be more abundant in the northern than in the southern areas.

J. J. ZIJLSTRA,
K. H. POSTUMA

Tuna

The Norwegian Tuna Investigations in 1959

(Figures 5–10; Tables 3–6)

1. The migration patterns

In *Annales Biologiques* for 1958, the present writer has touched upon the problems concerning the migration of the bluefin tuna (*Thunnus thynnus* L.) to the Norwegian coastal waters. On the basis of catch statistics, collected since 1954 and age determinations of the fish, the tuna stock can be separated in different contingents of tuna, according to different size or age of the fish, and time and place of occurrence. In accordance with these results, the Norwegian fishing grounds have been divided in a northern and a southern fishing area, including the landing districts I–III and V–VIII respectively (HAMRE, 1960). The tuna caught in the North belong to the contingent of the oldest fish, occurring in the beginning of the season (July). In the South, however, the fishing grounds are frequented by two contingents of fish (three in 1955). The first, which contains the tuna of “middle age”, generally arrives at the same time as the tuna in the North. Some weeks later, they are replaced by a new contingent of tuna which contains the youngest fish caught by Norwegian fishermen. The district IV may be regarded as a transition area, being in the early season apparently frequented by the old fish of the northern area, while at the very end of the season by the young tuna from the southern one.

Assuming that the different tuna contingents belong to the same population, the tuna must change its migration pattern with increasing age. On the basis of the catch statistics, 4 years' field observations, and last year's tagging experiments, the migration routes of the tuna have been studied, and it is possible to distinguish some recurrent features in the waters concerned. In accordance with the three different tuna contingents described, the tuna, when feeding in Norwegian coastal waters, seem to follow three different migration patterns, apparently related to the size or age of the fish. When a tuna contingent appears for the first time, the dominating year-class consists of 5 or 6 year-old fish. About the middle of September they usually arrive in the southern part of district VI, but may also appear so far south as Oslofjord and Skagerak. For some weeks they are feeding in the waters concerned, but at the very end of the season they migrate northwards, and have been recorded so far north as in district IV. This pattern may be called the first migration pattern.

When the fish grow older, they may arrive earlier

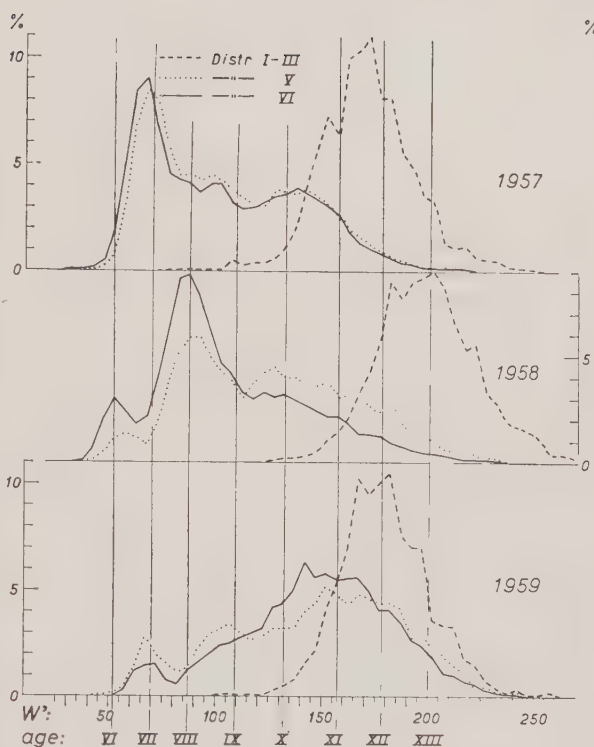


Figure 5. Weight composition (W' = commercial weight in kg) of Norwegian tuna landings by districts, 1957–59.

and further north, but seem in the main to follow the first migration pattern until the fish of the dominating year-class have reached an age of 8 to 10 years. Then the contingent of tuna which now belong to the “middle age” fish, changes over to follow the second migration pattern, which is characterized by a migration southwards along the Norwegian west coast. The tuna commonly arrive in district V, and constitute the first run to the southern fishing area. Some days later they appear in the northern part of district VI, in which they will be feeding for a shorter or longer period. But the main fishery is, however, moving gradually southwards, and the fishermen seem to lose contact with the “middle age” fish in the southern part of district VI or in the district VII. As shown by MEYER-WAARDEN and TIEWS (1959), this tuna contingent migrate into the North Sea region.

The tuna of the “middle age” seem to follow the second migration pattern until the fish have reached an age of about 12 years. Then the fish change their feeding grounds following a third migration pattern which brings the fish to the northern fishing area. The first year they may arrive so far south as in district IV (the transition area), but will move

Table 3. Weight frequency distribution ($^{\circ}/_{00}$) of Norwegian caught tuna, for districts III and IV in 1959 (total catches; 1,656 and 1,103 fish respectively)

Group mean (kg)	District III Weeks		Total	District IV Week	
	30	31		36	
62	—	—	—	8	
67	—	—	—	19	
72	—	—	—	21	
77	—	—	—	13	
82	—	—	—	9	
87	—	—	—	8	
92	—	—	—	12	
97	—	—	—	16	
102	—	6	1	22	
107	—	6	1	25	
112	—	—	—	20	
117	2	—	1	31	
122	1	—	1	14	
127	3	6	3	22	
132	5	11	5	30	
137	8	11	8	25	
142	12	45	15	24	
147	19	39	21	31	
152	42	51	42	47	
157	54	62	54	46	
162	67	96	69	40	
167	103	118	103	51	
172	101	73	96	46	
177	103	101	101	61	
182	111	84	106	53	
187	79	90	78	44	
192	71	51	70	51	
197	74	56	71	44	
202	37	23	37	49	
207	32	17	33	37	
212	32	34	32	24	
217	15	—	17	22	
222	16	—	14	12	
227	8	6	8	11	
232	3	—	4	8	
237	1	6	1	2	
242	4	11	5	3	
247	—	—	1	4	
252	—	—	1	—	
257	2	—	2	1	
262	—	—	1	—	
n	1,344	178	1,557	1,012	

Table 4. Weight frequency distribution ($^{\circ}/_{00}$) of Norwegian caught tuna, for district V in 1959 (total catch 4,059 fish)

Group mean (kg)	Week numbers								Total
	30	31	32	33	34	36	37		
47	—	5	—	—	—	—	4	1	
52	—	—	—	—	—	2	7	2	
57	—	—	—	6	—	4	4	3	
62	—	—	—	3	—	16	46	14	
67	4	—	—	3	6	24	113	28	
72	—	—	—	—	—	17	84	19	
77	—	—	—	—	6	18	51	16	
82	—	—	—	—	12	11	35	11	
87	—	—	—	3	9	15	20	11	
92	—	—	—	9	33	22	57	22	
97	—	—	4	6	33	37	51	29	
102	—	—	—	9	24	42	64	32	
107	—	5	—	3	51	39	68	33	
112	4	—	4	14	36	36	49	29	
117	4	—	—	14	42	34	33	27	
122	9	11	13	11	27	33	51	28	
127	26	11	13	26	48	38	24	32	
132	13	22	17	51	62	33	16	32	
137	30	27	34	40	53	33	13	32	
142	34	38	21	34	68	46	16	40	
147	51	65	47	63	51	42	22	45	
152	64	92	76	63	62	45	29	52	
157	68	87	68	51	45	47	11	48	
162	64	70	72	91	36	35	13	44	
167	94	81	68	74	68	34	20	48	
172	115	76	76	57	42	39	13	47	
177	86	92	127	68	27	30	13	44	
182	86	76	76	63	45	38	7	45	
187	68	60	93	60	21	37	16	42	
192	56	43	30	34	24	27	4	27	
197	34	65	72	37	6	27	13	29	
202	26	32	47	23	3	27	9	24	
207	9	5	17	29	15	24	9	19	
212	21	11	4	26	9	18	2	15	
217	21	16	13	3	12	10	9	11	
222	—	—	—	3	6	7	2	4	
227	—	5	9	9	9	5	—	5	
232	4	—	—	3	3	4	—	3	
237	—	—	—	6	6	2	2	3	
242	9	—	—	3	3	3	—	3	
247	—	5	—	—	—	1	—	1	
252	—	—	—	—	—	1	—	1	
257	—	—	—	6	—	—	—	1	
n	234	185	236	351	337	1,844	453	3,640	

further to the north with increasing age. When reaching the coast, the fish apparently migrate towards north. After feeding in the northern fishing area for two or three years, the tuna seem to disappear from the Norwegian coastal waters altogether.

II. The weight frequency distributions in 1959, compared with earlier years

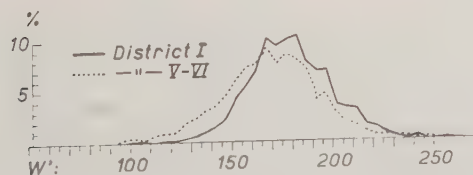
The Norwegian total catch of bluefin tuna in 1959 amounted to 16,498 fish or 2,492,366 kg. Compared with 1958 it means a decrease in the yield of 4,854 fish or 390,175 kg. Tables 3—5 show the weight distribution of the tuna landed in districts

III—VI, respectively. The collection of the statistical data, and the grouping of the material has been made in the same way as for the previous years (HAMRE, 1960). In Figure 5 is shown the weight frequency curves of the tuna landed in districts III, V, and VI. Corresponding curves for 1957 and 1958 are included for comparison.

In accordance with the tuna migration patterns described, it was expected that in this year's season the contingent dominated by the 1947 year-class, would replace the old fish in the northern fishing area. Figure 5 partly confirms that supposition. However, studying the weight frequency distribution of the landings in the districts V and

Table 5. Weight frequency distribution ($^0/_{00}$) of Norwegian caught tuna, for district VI in 1959. Total catch 9,635 fish

Group mean (kg)	Week numbers							Total
	30	31	32	33	34	36	37	
32	—	—	—	—	×	—	—	×
37	—	—	—	—	×	—	—	×
42	—	—	—	—	—	—	—	—
47	—	—	—	—	—	—	—	—
52	—	—	—	×	1	1	—	×
57	—	—	—	×	2	24	11	3
62	—	—	2	2	5	86	32	11
67	—	—	2	×	6	96	77	14
72	—	—	2	3	6	86	119	14
77	—	—	2	1	4	50	67	8
82	—	—	—	4	4	26	56	6
87	—	1	6	2	11	46	60	12
92	—	—	—	6	19	43	81	16
97	—	1	4	6	20	73	77	20
102	3	—	15	14	25	75	67	24
107	—	—	10	14	31	54	91	26
112	—	7	13	15	36	53	49	28
117	3	10	23	22	42	28	18	30
122	3	10	17	22	46	29	28	32
127	17	14	21	38	57	25	28	42
132	19	18	37	41	57	21	11	43
137	31	23	39	49	63	30	14	50
142	50	31	35	70	78	21	7	63
147	25	41	60	56	70	20	11	56
152	47	55	64	72	63	20	14	59
157	78	85	54	60	55	8	11	54
162	67	93	73	65	49	16	7	54
167	128	95	81	75	39	13	14	55
172	86	84	75	63	40	11	4	49
177	92	84	62	47	35	10	7	42
182	67	99	58	56	27	8	14	41
187	86	68	56	48	24	4	—	35
192	56	35	35	40	20	5	4	27
197	50	34	50	33	16	5	11	23
202	42	33	37	22	14	5	11	19
207	25	26	13	14	9	1	4	11
212	3	20	19	15	7	—	—	10
217	8	9	4	10	7	1	—	7
222	6	3	8	8	6	3	—	6
227	6	7	10	3	3	1	—	4
232	—	7	4	3	2	—	—	3
237	—	7	8	2	1	—	—	2
242	3	—	—	—	1	1	—	1
247	—	1	—	2	1	—	—	1
252	3	—	—	—	×	—	—	×
257	—	—	—	×	—	—	—	×
262	—	—	—	×	—	1	—	×
n	360	707	482	2,517	4,462	799	285	9,632

Figure 6. Weight composition (W' = commercial weight in kg) of Norwegian tuna landings by districts, in the weeks 30-32, 1959.

VI (Tables 4 and 5), one will in the first weekly catches recognize fish of the same size. This feature is demonstrated more clearly in Figure 6, in which the weight composition pattern of the landings to the northern and southern fishing areas during the weeks 30-32 have been compared. The contingent concerned has been divided into two parts. The one part migrated very rapidly toward north, and the fishing boats lost contact with the fish in the northern part of district III. The other one, which probably contained a relatively small quantity of fish, followed the second migration pattern as in previous years (compare the tagging experiments).

The tuna contingent dominated by the 1950 year-class (in 1955 by the 1949 year-class) has followed the first migration pattern since the fish appeared for the first time in 1955. It was expected that the tuna fishery in 1959 mainly would be based upon the tuna of the 1950 year-class, and there was a fair chance that the fish now would change over to follow the second migration pattern along the Norwegian coast. Figure 5 shows, however, a considerable decrease in the relative strength of the 1950 year-class, compared with earlier years. What has happened may be explained as due to the prevailing fishing conditions.

III. Special fishing conditions

Owing to the fact that the wind transport of the surface water masses in the open sea is directed, in the northern hemisphere, 90° to the right of the wind, the wind from the north will transport the light and (in the summer) warm surface water masses away from the Norwegian west coast, producing an upwelling of the subsurface water. This happened during the 1959 tuna fishing season in district VI, and has, without doubt, greatly influenced the tuna fishery (Fig. 7).

Figure 8 shows the variations in the wind components blowing along the coast (observations from the meteorological station at Utsira, Figure 10) compared with the variations in the surface temperature and salinity at the positions $60^\circ 08'N$, $5^\circ E$ and $59^\circ 02'N$, $3^\circ 30'E$ (observations by the Oceanographical Section of the Norwegian Institute of Marine Research, kindly placed to the author's disposal by Dr. EGGVIN). At the bottom of the figure are shown the weekly catches in districts V (shaded columns) and VI (black columns).

In week 33 a new run of tuna invaded the fishing grounds in district VI. It seems likely that the new run has been the "forerunners" to the tuna contingent dominated by the year-classes 1950 and

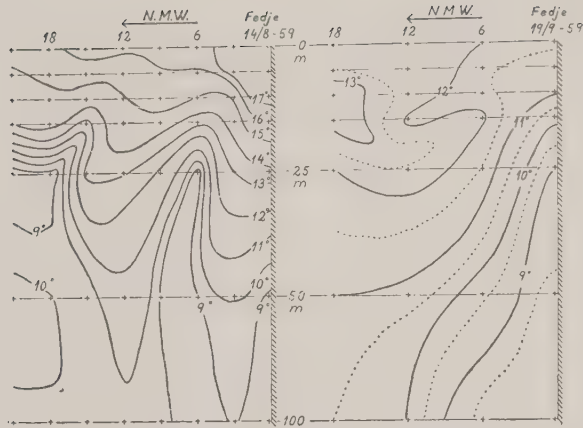


Figure 7. Temperature sections west of Fedje in the summer of 1959 (+ denotes observation point).

1949 (see Table 5). The fish arrived in a period in which the hydrographical conditions probably were unusually good for the purse-seine tuna fishery, the yield thus being relatively high in relation to the abundance of fish. A light wind from the south and high air temperature had established a situation of a thin layer of warm water from the surface to about 15 m depth on the fishing grounds where the purse-seining usually takes place (between the stations, 3 and 9 nautical miles off, Figure 7). Great quantities of food organisms, on which the tuna were feeding, were observed by the fishermen and the thermocline between 15 and 25 m may have restricted the vertical distribution. As the purse-seining only takes place after fish have been observed at the surface, it seems fair to regard this as an excellent situation for the Norwegian tuna fishing.

However, when the 1950 year-class was expected to arrive in full force (week 35), the wind changed over to the north. The very rapid decrease in salinity at position 3°E shows that the surface water has been transported from the coast, probably together with the food organisms upon which the tuna were feeding. In accordance with this, observations of tuna up to 50 nautical miles off were frequently reported by passenger steamers and other boats passing by during that time. The purse-seiners, however, do not operate so far from the coast, and consequently the yield of the fishery in the area concerned became extremely low during the period when the best fishery was expected. This circumstance thus explains why the weight composition pattern of the total landings in district VI in 1959 has changed, compared to earlier years (Figure 5). In week 38 the north wind blew up again, resulting in a new transport of surface

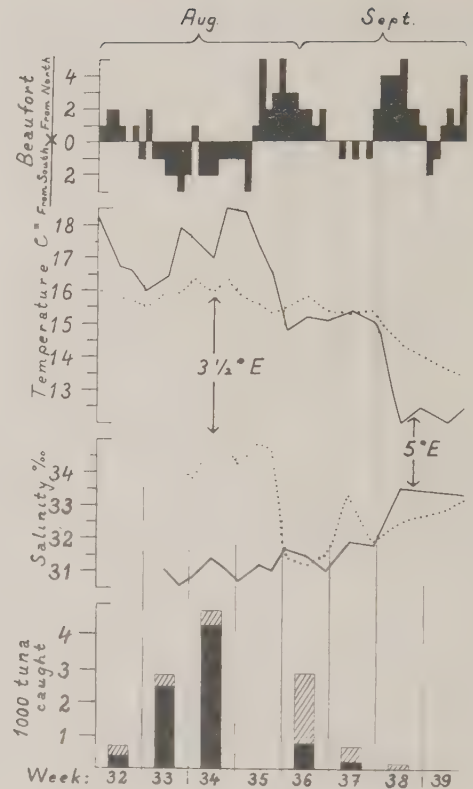


Figure 8. Weekly catches in district V (shaded columns) and in district VI (black columns), compared with the surface temperature and salinity. Wind components along the coast.

water towards west, which can be recognized in the decrease of temperature and, which is the strongest indication, the rise in the salinity near the coast.

It is fair to assume that the same weather conditions also have influenced the tuna fishery in district V, but probably to a lesser extent. The main bulk of Norwegian catches in week 36 was landed in the district concerned. In the weeks 37 and 38, however, it can be concluded from meteorological observations that strong winds (first from the south, and changing over to the north), may have stopped the purse-seining in the open sea of district V.

Owing to these unfavourable changes in the fishing conditions, it has been difficult to follow the last tuna contingent on its migration along the Norwegian coast. The landings in districts IV and V (Tables 3 and 4) at the end of the season point, however, in the direction of a migration northwards, i.e. after the first migration pattern. The recapture in the vicinity of the isle of Anholdt (Kattegat) of a tunny tagged in the southern part of



Figure 9. Tuna tagging. For further explanation, see text.

Table 6. Release and recovery data for tagged bluefin tuna

No.	Date	Release Locality	Recapture Date	Recapture Locality	Days at liberty	Weight in kg (w)
1	Sept. 15, 1958	N 59°35', E 5°04'	June 19, 1959	Cadiz, Spain	275	176
2	Sept. 15, 1958	N 59°32', E 5°04'	June 20, 1959	Cadiz, Spain	278	138
3	Sept. 17, 1958	N 59°38', E 5°02'	Aug. 20, 1959	N 59°55', E 5°00'	339	138
4	Sept. 17, 1958	N 59°38', E 5°02'	July 4, 1959	Cadiz, Spain	290	153
5	Aug. 10, 1959	N 60°55', E 4°25'	Aug. 17, 1959	N 60°15', E 4°45'	7	218
6	Aug. 10, 1959	N 60°55', E 4°25'	Aug. 17, 1959	N 60°00', E 4°45'	7	223
7	Aug. 12, 1959	N 60°30', E 4°40'	Aug. 17, 1959	N 60°30', E 4°40'	5	—
8	Aug. 12, 1959	N 60°30', E 4°40'	Aug. 18, 1959	N 60°05', E 4°50'	6	218
9	Aug. 21, 1959	N 59°30', E 5°05'	Oct. 6, 1959	Anholt Is.	46	170

district VI shows that a migration southwards also has taken place, but according to the German investigations (MEYER-WAARDEN and TIEWS, 1959), these schools have hardly contained fish of the 1950 year-class.

IV. Tagging experiments

The Norwegian tuna tagging experiment was continued in 1959. The Lea hydrostatic tag was used, attached to the fish by means of a plastic harpoon head, inserted into the muscles by a solid steel cylinder fitting into a hole in the base of the harpoon (Figure 9).

Only purse-seine caught tuna has been used, the tagging operation is illustrated in Figure 9. The

tuna, which are more or less suffocated due to lack of oxygen, are caught by a hook in the lower jaw and brought onto a trough of aluminium, strengthened by an iron band at the far end. The nearer end is laced on to the seine as shown in the figure. Two ropes, fastened to the iron band, are crossed over the fish, and when the tuna is unhooked and tagged, the fish is released by pulling the ropes.

During the season, 42 tuna have been tagged, 9 in district V and 33 in district VI. Most of the fish seemed to be in good condition after release, but as doubtful cases we have noted 5 fish. None of these has been recaptured. The data of the fish recaptured are given in Table 6. The main features of this table may be summarized as follows (Fig. 10):—



Figure 10. 1959 recaptures of Norwegian tagged tuna.

1. That there is a certain exchange of fish between the south coast of Spain and Norwegian waters.
2. That the tuna which occur in district V at the beginning of the season migrate southwards along the Norwegian coast.
3. That a migration of tuna from district VI to Kattegat has taken place.

JOHS. HAMRE

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German Tuna Landings in 1959 and their Age Composition

(Tables 7-9)

In 1959, the German tuna landings amounted to 976.8 metric tons which is 2.5 times higher than in 1958 (380 tons) when tuna fishing was a failure for German fishermen, but which is lower than in 1957 (1,286 tons), the most successful catch season until now. A total of 3,818 tunas were caught on the usual fishing grounds, chiefly located in the western part of the central North Sea (1). 7.9% of the catch was made in August, 65.3% in September, and 26.8% in October.

Length measurements have been carried out on tunas since 1951, and in 1959 3,179 tunas were measured.

The average weight of the tunas was 256 kg (gutted, but with heads and gills), the average fork length 239.93 ± 0.16 cm. Similar to previous years, the feeding coefficient is rapidly increasing from August to October (1).

Table 7. Length distribution (‰)

cm	205	210	215	220	225	230	235
1959 . . .	1	1	9	28	86	162	230
cm 240	245	250	255	260	265	270	275
1959 209	157	64	34	13	6	—	0

Number 3,179

Table 8. Average length, weight, and feeding coefficient (K)

	n	$\bar{X}$ in cm	$S\bar{X}$	$\bar{X}$ in kg	K
August	267	241.920	0.595	254	1.809
September . . .	2,267	239.335	0.185	250	1.831
October	645	241.215	0.365	270	1.928
Total	3,179	239.930	0.161	256	1.860

Table 9. Age composition of the German tuna catches in 1959

Age-group	Year-class	Number of specimens	%	Mean length in cm
XII	1947	1,110	29.0	234.83 ± 0.34
XIII	1946	2,327	61.0	240.73 ± 0.24
XIV	1945	381	10.0	247.53 ± 0.64
Total 1945-1947		3,818	100.0	239.93 ± 0.16

During 1959 an attempt was made to determine the relative age of tunas by means of the ratio of eye diameter and fork length (2). For this purpose the eye diameter of 1,607 tunas of known length was measured. Three groups of tuna, clearly distinguished by their eye diameter, could be separated. It is very likely that the three groups correspond with the year-classes 1945, 1946, and 1947, and with age-groups XIV, XIII, and XII, as may be concluded from the age determinations of various authors. The proportions of the single age-groups of the total catch are shown in Table 9. Most of the tuna caught in 1959 were 13 years old.

KLAUS TIEWS

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Two New Parasites in North Sea Tuna

In some cases it has been possible to distinguish population units of fish by means of their infection rate of parasites, which may be useful as natural tags. Since little is known about the occurrence and

abundance of parasites in tuna fish, some attention has been paid to search for parasites in bluefin tunas of the North Sea. Results of these investigations were previously reported (2). A total of eight different parasites could be detected. Three of these were *Copepoda parasitica*, two monogene trematodes, two digene trematodes, and one nematode.

In 1959, further two species of parasitical copepods have been discovered and were identified in the Zoological Museum of the Humboldt University in Berlin. Both belonged to the genera *Pennella* (Oken 1815). They are *Pennella filosa* (Linnaeus 1758) and *Pennella orthagorisci* (Wright 1870) (1,3). As far as we know these two species have not previously been observed in tunas, only in sunfish, *Orthogoriscus mola*.

The species are the largest among the known parasites of tunas and measure about 10 cm. They live ectoparasitically and are attached to the skin anywhere, mostly behind the pectoral fins. They seem to be rare. Only three specimens of each of the two species were observed during the whole period of study since 1953. They may, however, be more abundant, but are easily lost during the rough catching procedure.

KLAUS TIEWS

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Etudes sur les Thons, *Thunnus thynnus* (L.),
de la Côte Portugaise

Poursuivant les études commencées en 1958 (*Annales Biologiques*, XV, 1958) on a obtenu en 1959 les résultats suivants.

Les données concernant chaque année, 1958 et 1959, sont comparées ici.

I. Rapport longueur/poids

L'étude des 590 exemplaires observés, dont la longueur était comprise entre 110 et 287 cm (203 pêches en 1958 et 387 en 1959) nous a conduit aux équations suivantes:

$$P = 0,00018 L^3 \text{ et } L = 38,51 P^{1/3}$$

le coefficient de corrélation étant $R = 0,996$.

Considérant séparément les thons pêchés en 1958 et ceux de 1959 nous avons déterminé les équations :

$$\begin{array}{cc} 1958 & 1959 \\ P = 0,00019 L^3 & P = 0,00017 L^3 \end{array}$$

En comparant ces deux équations on peut conclure que les thons de 1958 étaient relativement plus lourdes que ceux de 1959, ce qui confirme l'impression obtenue par les pêcheurs et les ouvriers des usines de conserves, et par nous-mêmes pendant nos observations. En même temps est mise en évidence la variation qui peut présenter le rapport longueur/poids chez ces animaux.

II. La ponte et le poids des thons

On considère en Portugal deux époques dans la pêche du thon: de *course*, depuis la fin d'avril, ou du début de mai, jusqu'à la fin de juin; de *retour*, comprenant juillet et août.

Bien que les limites des deux époques ne soient pas rigoureusement déterminées, l'exacte délimitation n'étant d'ailleurs pas possible, on a vérifié, depuis beaucoup de temps, que ces limites s'adaptent, ou sont très proches de la réalité.

En effet jusqu'à la fin de juin on ne trouve pas, normalement, des individus dont les gonades sont vides.

D'autre part, dans la deuxième époque, on ne trouve que de rares exemplaires à gonades pleines, et pas toujours après la fin de la première semaine de juillet.

Cette année, 1959, s'est révélée exceptionnelle à cet égard. En effet, jusqu'à la fin de la troisième semaine de juillet on a observé beaucoup d'exemplaires dont les gonades étaient pleines et d'autres n'ayant pas encore accompli la ponte.

Conséquemment la différence entre le poids des thons de course et celui des thons, de la même longueur, de l'époque de retour, pendant 1958, donnée en pourcentages du poids des thons de course, s'est montrée plus marquée que celle vérifiée cette année.

Les chiffres concernant les deux années sont présentés dans le Tableau 10.

Tableau 10. Poids perdu par les thons pendant la phase finale de la reproduction, en % du poids des thons de course

Longueur, cm	% du poids perdu	
	1958	1959
150	24,8	—
160	17,7	9,5
170	—	4,3
180	12,8	6,8
190	16,1	2,9
200	18,6	9,9
210	18,8	13,9
220	15,9	13,5
230	22,2	4,9

III. Proportion des sexes

Ainsi qu'en 1958, le nombre des femelles a dépassé, en 1959, celui des mâles. Et, cas curieux à signaler, les pourcentages des sexes ont été très semblables pendant les deux années, soit en considérant les deux époques séparément (de course et de retour), soit l'ensemble.

En effet le nombre des mâles (Tableau 11), a été toujours seulement un peu supérieur à un tiers de la totalité. Coïncidence ou normalité c'est une chose qu'il faut voir dans les années suivantes.

Sur 527 exemplaires, c'est-à-dire, le nombre total des individus dont le sexe a été déterminé, les pourcentages de femelles et des mâles ont été, respectivement, les suivantes: femelles, 63,2%; mâles, 36,8%.

IV. Produit de la pêche

Puisque, depuis toujours et jusqu'à 1957, les thons pêchés par les madragues étaient vendus à vue d'oeil, les bulletins statistiques ne mentionnaient pas le poids, mais seulement le nombre de poissons par des catégories de taille: atuns, atuarros, albacoras et cachorretas.

Ces catégories s'enchainent de la façon suivante: 1 atum = 2 atuarros; 1 atuarro = 2 albacoras; 1 albacora = 2 cachorretas. Ce rapport manque de rigueur quoi qu'il en soit les catégories considérées et surtout en ce qui concerne les deux dernières.

Dans le but de rendre comparables les résultats totaux de la pêche dans la période consi-

Tableau 11. Proportion des sexes

Total		1958		Années		1959		Total	
N	%	N	%	Sexes		N	%	N	%
136	63,6	47	64,4	Mai-Juin		83	62,4	197	62,9
78	36,4	26	35,6			50	37,6	116	37,1
214	100,0	73	100,0	Mai-Juin		133	100,0	313	100,0
				Femelles	114	63,3			
				Mâles	66	36,7			
				Total	180	100,0			

Tableau 12. Des thons pêchés par les madragues 1931-1959

Années	Nombre d'individus				Total	Tonnes				Total
	Atuns	Atuar- ros	Albaco- ras	Cachor- retas		Atuns	Atuar- ros	Albaco- ras	Cachor- retas	
1931	11787	2859	1068	259	15973	1650,2	208,7	45,9	0,9	1906
1932	13969	915	638	149	15671	1955,7	66,8	27,4	0,5	2050
1933	13399	1559	1014	302	16274	1875,9	113,8	43,6	1,1	2034
1934	6958	818	678	361	8815	974,1	59,7	29,2	1,3	1064
1935	6230	1819	813	164	9026	872,2	132,8	35,0	0,6	1041
1936	15837	4792	1705	333	22667	2217,2	349,8	73,3	1,2	2642
1937	31856	3973	4868	378	41075	4459,8	290,0	209,3	1,3	4960
1938	6831	3217	3341	729	14118	956,3	234,8	143,7	2,6	1337
1939	4620	2907	1555	189	9271	646,8	212,2	66,9	0,7	927
1940	4199	1974	3381	452	10006	587,9	144,1	145,4	1,6	879
1941	7270	2969	1839	1026	13104	1017,8	216,7	79,1	3,6	1317
1942	6809	2659	2236	589	12293	953,3	194,1	96,1	2,1	1246
1943	20897	5360	5233	913	32403	2925,6	391,3	225,0	3,2	3545
1944	11960	3858	2411	592	18821	1674,4	281,6	103,7	2,1	2062
1945	8335	4978	3193	825	17331	1166,9	363,4	137,3	2,9	1671
1946	19738	6752	1930	898	29318	2763,3	492,9	83,0	3,1	3342
1947	10738	5720	3904	2218	22580	1503,3	417,6	167,9	7,8	2097
1948	10700	5089	2677	1251	19717	1498,0	371,5	115,1	4,4	1989
1949	12360	4381	2596	778	20115	1730,4	319,8	111,6	2,7	2165
1950	7639	4558	2600	2082	16879	1069,5	332,7	111,8	7,3	1521
1951	6795	3790	2956	4008	17549	951,3	276,7	127,1	14,0	1369
1952	10316	6531	4108	526	21481	1444,2	476,8	176,6	1,8	2099
1953	15554	5687	2645	1048	24934	2177,6	415,2	113,7	3,7	2710
1954	6567	3486	1079	899	12031	919,4	254,5	46,4	3,1	1223
1955	7108	2384	440	338	10270	995,1	174,0	18,9	1,2	1189
1956	14178	3348	1050	684	19260	1984,9	244,4	45,2	2,4	2277
1957	5121	1540	426	347	7434	716,9	112,4	18,3	1,2	849
1958	3992	1424	145	192	5753	558,9	104,0	6,2	0,7	670
1959	5583	1405	163	8693	15844	781,6	102,6	7,0	30,4	922

Moyenne annuelle de la période: 1831 tonnes.

dérée, 1931—1959, en employant un criterium plus acceptable que celui-là, nous avons déterminé le poids moyen de chaque catégorie dans les années 1958 et 1959 pour faire la conversion du nombre des individus en poids.

Les moyennes obtenues ont été les suivantes (en kg):—

Atuns	140
Atuarros	73
Albacoras	43
Cachorretas	3,5

Dans le tableau (Tableau 12), ainsi élaboré, nous voyons que le produit annuel de la pêche a varié le long de la période, et très irrégulièrement, entre 670 et 4960 tonnes, la moyenne étant 1831 tonnes. Vraiment frappants sont les résultats dans le triennat 1957—1959.

Etant donné que dans cette longue période on a employé les mêmes madragues (5 madragues), placées dans les mêmes endroits, et en opérant toujours de la même façon, il faut admettre, pour expliquer la diversité des résultats, l'influence des facteurs autres que la méthode de pêche.

En effet on pourra admettre l'influence des changements du milieu physique, de l'abondance ou manque de nourriture, des phénomènes biologiques, et des diverses activités de la pêche dans des mers proches ou éloignées, etc.

Les années 1937 et 1958 ont été nettement exceptionnelles à cet égard: en 1937 on a pêché la plus grande quantité, 4960 tonnes, et en 1958, la plus petite, 670 tonnes.

Le graphique (Figure 11), met en évidence la tendance à la formation des groupes d'années dont les produits de la pêche sont inférieurs ou supérieurs à la moyenne générale, c'est-à-dire, des périodes d'abondance et des périodes de crise.

Considérant comme exceptionnelles les années 1945 et 1956 on peut constater, par exemple, deux périodes de pêche relativement pauvre, 1938—1942 et 1954—1959, séparées par une période de pêche abondante, 1943—1949.

D'après l'histogramme (Figure 12), dans lequel l'irrégularité de la pêche se révèle aussi très nettement, on peut voir que les exemplaires de grande taille, les atuns et les atuarros, surtout les premiers, ont été les poissons les plus abondamment capturés par les madragues. Après ceux-ci viennent les

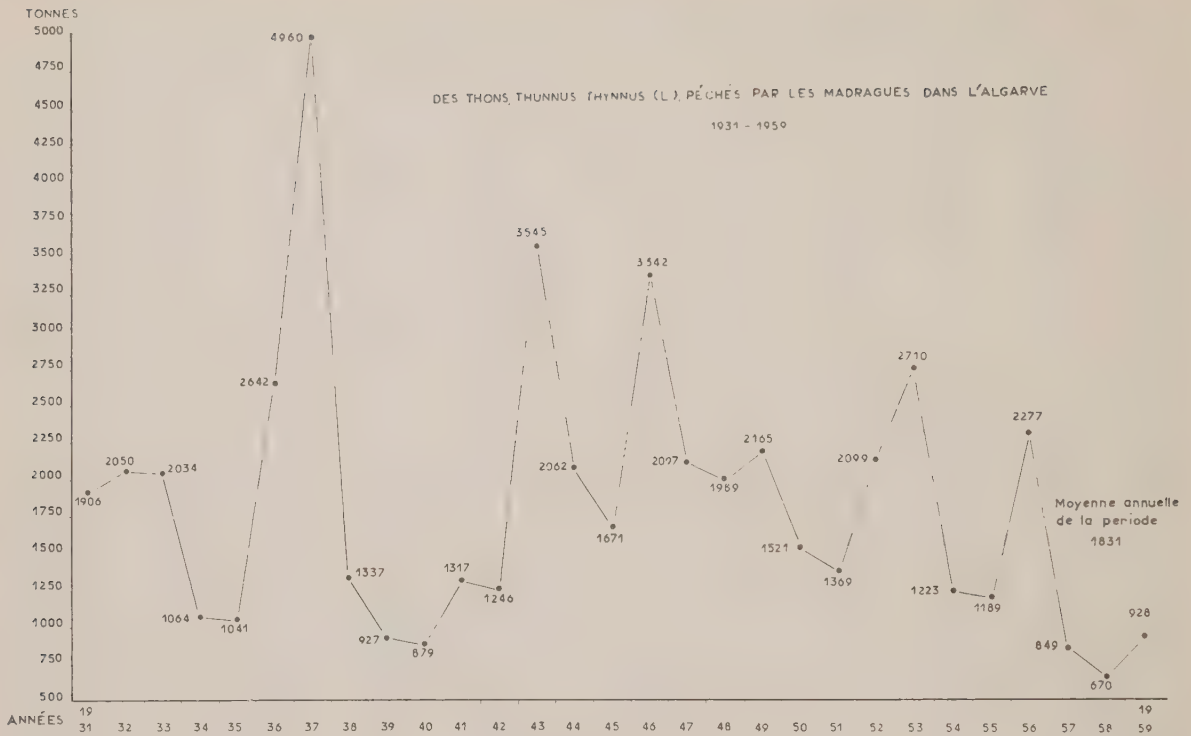


Figure 11.

albacoras et; finalement, les plus petits: les cachorretas.

La dernière saison de pêche, mai—juin 1959, s'est révélée exceptionnelle à cet égard. En effet le nombre de cachorretas, 8593, a bien dépassé le nombre d'exemplaires de chacune des catégories considérées, et même la totalité de celles-ci, 7151 individus. Au nombre élevé de ces petits poissons on voit d'ailleurs la supériorité en poids de l'année 1959 dans le dernier triennat.

Il faut ajouter que les cachorretas sont normalement capturés, en groupes plus ou moins indépendants, et plus ou moins nombreux surtout vers la fin de la saison, ce qui nous mène à admettre une certaine uniformité des bancs de thons.

V. Résumé

Ces études, concernant les années 1958 et 1959, nous amènent aux conclusions suivantes, pas encore définitives puisqu'elles seront continuées l'année prochaine.

(a) Les thons observés en 1958 ($P = 0,00019 L^3$) étaient relativement plus lourdes que ceux observés en 1959: ($P = 0,00017 L^3$); cette différence a mis en évidence que le rapport longueur/poids du corps peut varier chez ces poissons.

(b) La différence entre les poids des thons pêchés dans la période mai—juin et de ceux capturés pendant juillet—août a été, en 1958, supérieure à celle vérifiée en 1959. La présence exceptionnelle de nombreux thons à gonades pleines jusqu'à la fin de juillet de cette année doit être la raison principale de la divergence.

(c) Le nombre des mâles a été toujours inférieur à celui des femelles (un peu supérieur à 1/3 de la totalité) quoi qu'il en soit l'époque ou l'année considérés.

(d) Pendant la période 1931—1959 on a vérifié des grandes fluctuations dans les captures (670 tonnes en 1958, et 4960 tonnes en 1937), et une certaine tendance à la formation des groupes d'années de pêche pauvre et des groupes d'années de pêche abondante. Le triennat 1957—1959 a été le plus pauvre.

(e) Le nombre des thons de petite taille, cachorretas toujours très bas, au moins pendant la période 1931—1959, a dépassé nettement, en 1959, l'ensemble de celui des autres catégories: atuns, aturros, et albacoras. Normalement les exemplaires de grande taille (atuns) sont les plus abondamment pêchés avec des madragues.

H. VILELA et E. CADIMA

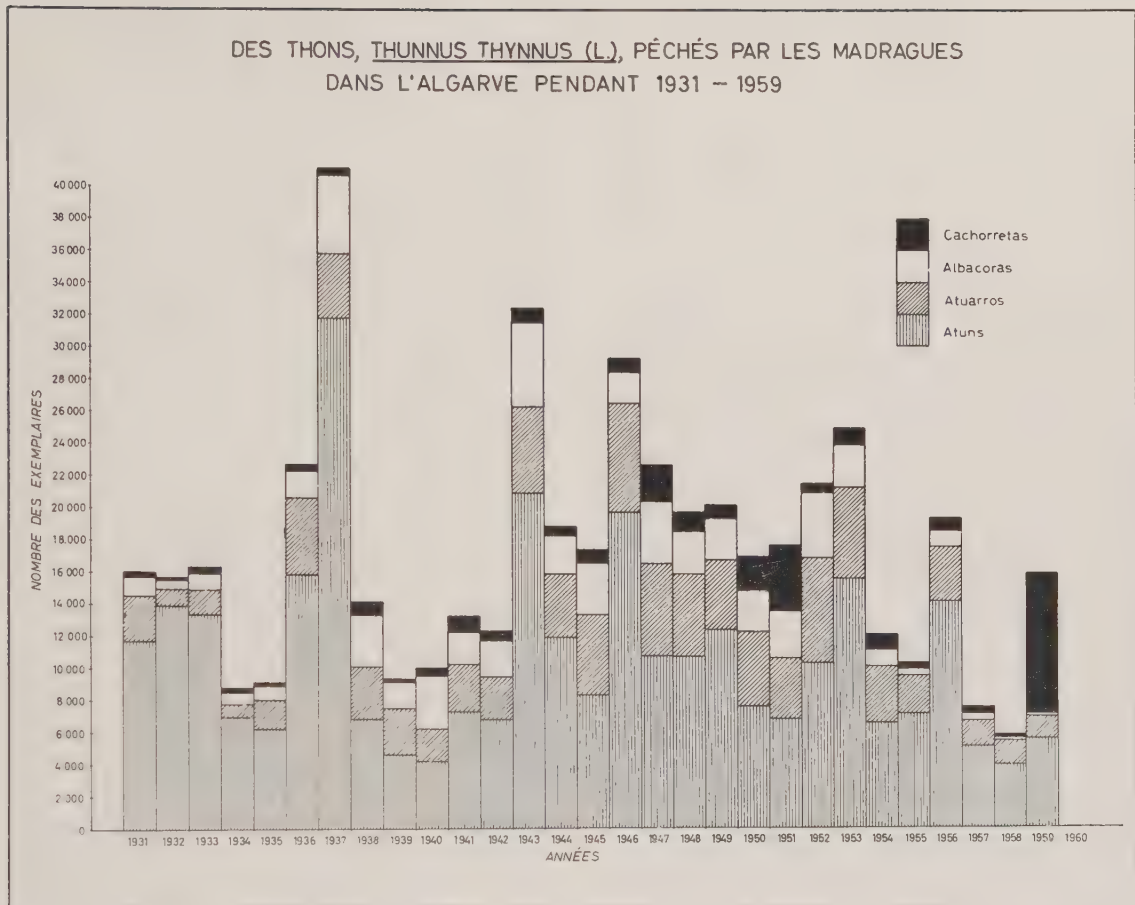


Figure 12. Nombre d'individus des diverses catégories de taille, pêchés pendant 1931-1959.

Salmon and Trout

England and Wales

River Axe Salmon and Sea-Trout Investigations

During the early part of 1959 the basic structure of the trapping installation at Colyford, Devon, was strengthened and it was not possible to fish it until the 28. April. From this date until 20. July the trap was fished except for three short intervals when improvements were being made to the gear. It was apparent during this time, however, that fish were generally reluctant to leave the upstream trap and continue their migration and measures had to be devised to clear the trap without damaging the fish and between 20. July and 5. October the trap for ascending migrants was out of action while various parts of it were re-built. The descending migrant trap was, however, operating for most of this time except when very low water conditions rendered it unusable (sufficient water had necessarily to be let through a free gap to enable any ascending fish to run).

On the 5. October trapping was resumed for migrants moving in both directions and up to 19. November (by which time the trap had fished for 37% of the year) the totals of ascending salmon and sea-trout trapped and released upstream were respectively 360 and 1,051 (a ratio of approximately 1 to 3). Of these fish, 200 salmon and 801 sea-trout had passed up between 28. April and 20. July.

During the period of fishing up to 20. July, ascending salmon and sea-trout were tending to enter the trap mainly at night (64% of the salmon, 63% of the sea-trout) but during October and November the greater proportion of each species entered the trap during the daytime; a similar change towards the end of the migration season has been demonstrated in salmon and sea-trout smolts and elvers. When the salmon started to run on the autumn floods some fairly substantial catches were made, 55 being captured on one day and 85 on another. There was no similar run of sea-trout at the same time. During the spate which brought up these 55 salmon, 15 salmon parr were also trapped in the ascending migrant trap.

The descending migrant trap was not suitably gridded to catch smolts in the spring of 1959 but it was to be expected that some would, in fact, be caught or at least observed passing through the trap or in the pool above. This was not so, however, and very few were seen. It is thought that the main migration was over before 28. April.

Two floods fished during the period 10. to 14. December last year (1958) produced, on the descending trap, 8 salmon kelts, 173 sea-trout kelts, and 326 sea-trout whiting, as well as 10 brown trout. During the spring and summer very few fish other than grey mullet were caught by the descending migrant traps but on 27. October 1959, 9 salmon kelts were caught and tagged.

Up to the 16. November 10 salmon kelts and 197 sea-trout kelts and whiting had been tagged. One of the tagged sea-trout kelts, a fish of about 4 lbs. was found dead at Starcross Pier in the estuary of the River Exe, approximately 25 miles to the westward of the River Axe, fourteen days after being released from the Axe trap. No other recaptures have so far been made except of kelts released from the descending trap re-appearing in the ascending trap.

The incidence of major flooding on the River Axe has proved to be a good deal more frequent than expected (in the absence of any gauging records for this river), and this has necessitated a change in our operating policy.

It has now become necessary to accept that there are conditions under which the installation cannot be worked and that these conditions are likely to occur every year and often several times in a year. At such times the valley is flooded from side to side, and fish could in any case then bypass the trap.

The future policy will be to lower the descending migrant trap to the bottom of the river where least (if any) damage will be done to it by floating trash and timber, but it should be possible to resume fishing as soon as the peak of the flood has passed and the trap will be out of action for a matter of hours and not weeks.

Thus, under very high flood conditions the installation will no longer be a barrier to fish moving in either direction (if salmonids do migrate at such times). For this reason the marking of ascending fish trapped will be necessary in order to estimate the escapement.

In addition to the salmon investigation, the trapping installation presents the opportunity of learning more about the life history and ecology of sea-trout than has probably ever been possible before, and in particular about the sea-trout population of the Western English Channel, about which nothing is yet known.

I. R. H. ALLAN

A. SWAIN

M. J. BULLEID

Rivers Usk, Wye, and Severn Salmon-Smolt Tagging Experiment

In 1958, a series of experiments was begun with a view to obtaining information as to the origin of the salmon caught by the commercial nets operating in the lower reaches of the three estuaries. These experiments, involving the tagging of smolts, were continued in the spring of 1959.

In 1958 the smolts caught on the Rivers Usk and Wye were taken by a seine net, but on the Severn experience showed that an eel net was more efficient than a seine, and it was decided, therefore, that eel nets should be used on all three rivers in 1959.

The numbers tagged on each river were as follows:—

River Usk	585
River Wye	1311
River Severn	669
Total	2565

On the River Wye smolts were caught on the first day of the netting operations (31. March), and on each following day until 15. April. The maximum numbers were caught between 11. and 14. April when over 700 smolts were tagged in three nights. Between 16. and 19. April, the river was in flood and it was impossible to net. Except for a brief renewal of activity on the 24. and 25. April, very few fish were caught after the flood.

On the Severn, again the largest numbers were taken during the period 13. to 16. April; then, as on the Wye, a flood prevented further netting for several days, and after the flood very few fish were caught.

The catch of smolts on the Usk was most disappointing, only 27 being tagged there. However, while the netting was in progress, another experiment was being conducted at the Uskmouth Generating Station situated in the lower reaches of the estuary below Newport. Here, smolts which had come into the station via the cooling water intake, were netted out of the screen chambers and these operations were continued during April and May. Quite a large proportion of the smolts rescued in this way were in good condition and as the catches at Newbridge were very low it was decided to tag as many of the power station smolts as possible. These fish were stored for a short time in aerated tanks at the power station and were then released at a point further down the estuary. Altogether, 558 smolts were tagged at Uskmouth Power Station giving a total of 585 for the river.

Reports from various observers on the three rivers indicated that smolt runs were poor in 1959 and there were no reports of any large concentrations of smolts. Also, the season was rather early, with river temperatures somewhat higher than normal for late March and early April. It is possible, therefore, that a proportion of the smolts migrated before the nets were in operation and the catching of fairly large numbers of smolts during the first few days of netting on the Wye and Severn would tend to support this suggestion. After the floods in mid-April very few smolts were caught and the smolt migration on all three rivers was finished by the end of April.

During the 1959 fishing season none of the fish tagged as smolts in 1958 was caught. A smolt tagged at Newbridge-on-Usk on 9. April 1959 was taken in Uskmouth Power Station on 14. April.

A. SWAIN

International Tagging Tests with Salmon Smolts

At a symposium held by the Salmon and Trout Committee of the International Council for the Exploration of the Sea, it was recommended "That all member countries should carry out experiments to determine the comparative value of various types of tags and methods of tagging, and in particular, as part of this programme, teams from different countries should participate in joint tagging programmes as a test of different techniques."

Accordingly, it was arranged for a Swedish team to visit Norway and Scotland and English teams to visit Norway, Sweden, and Scotland in the spring of 1959.

Two types of tags were used by the English workers — a small square of Ivorine (celluloid) and a small diamond shaped piece of silver sheet. Both types were serially numbered and were threaded on to a short length of silver wire. The fish, which were not anaesthetized, were placed in a rubber holding block under water. A single hypodermic needle was inserted into the dorsal musculature slightly anterior to the dorsal fin. One end of the silver wire was threaded into the needle which was then removed, the other wire was passed over the fish, the two wires then twisted together and bent back to lie along the side of the fish.

The English/Scottish comparative tests were carried out in May at the smolt trap on the River Meig, Ross-shire, Scotland. Only light blue Ivorine tags were used for the English techniques and black and red telcothene tags for the Scottish technique. Approximately 1,000 smolts were tagged by each technique and they were all released into the River Meig.

In Norway, the English/Swedish/Norwegian tests were carried out at the Lundamoen Hatchery near Trondheim. Both types of English tag were used and altogether 2,058 smolts were tagged by these techniques. The smolts were two years old and had been reared in the Lundamoen Hatchery. The fish were all released into the Gaula River near Trondheim.

In Sweden, the English/Swedish tests were carried out at three different places on the Baltic coast. Again, both types of English tags were used. At Galtström, south of Sundsvall, 4,092 smolts were tagged. Normally, a very high percentage of recaptures is obtained from smolts released from this station and up to 10 per cent of the larger smolts have been recaptured as adult fish. All the smolts tagged at Galtström were large two year-old fish and they were released into the nearby River Ljungan. A further 1,250 smolts were tagged at Bergeforsen one of the largest Atlantic salmon hatching and rearing stations in the world, near the mouth of the Indalsälven, one of the large rivers flowing into the Gulf of Bothnia. Again the fish were 2 years old and after tagging they were released into an artificial channel from which they could migrate at any time into the main river.

The third batch of smolts were tagged at Lulavan on the Lule älv near the port of Luleå in northern Sweden. The smolts at this station were 2 years old and had been reared at Munka-Ljungby in southern Sweden, although the eggs had come from the north in the first instance. Only 631 smolts were tagged at Lulavan and they were released into the Lule älv.

It is hoped that some tagged fish will return in 1960 but it is clear that a statistical comparison of the methods of tagging employed in 1959 will not be possible until the end of the 1961 season.

A. SWAIN, I. R. H. ALLAN

Research on Osmoregulation in Salmon

The study of osmoregulation in salmon has been following three lines: a study of the total ionic concentration and of some individual ions in the blood of salmon at all available stages in the life-history; a study of the growth of salinity tolerance in salmon, brown trout, and rainbow trout; a histological study of the gills in freshwater and marine salmon. Some other lines of research have been pursued in collaboration with other workers.

1. Composition of salmon blood

The analysis of some common ions in the blood of salmon has been extended during the past 12 months to include estimates of calcium and carbonate. In general, additional analyses of all ions (sodium, potassium, calcium, chloride, carbonate) have confirmed the earlier results. A preliminary draft of a paper has been prepared embodying these results, and also measurements of freezing-point depression of the blood, during the migration of salmon (Title: Osmotic and ionic regulation in the Atlantic salmon during its life-history). Trimethylamine oxide has been analysed in a number of blood and muscle samples of salmon, but no conclusions relevant to osmoregulation could be drawn. The blood contains apparently no trimethylamine detectable by either a micro-diffusion analysis or a distillation method. The level of this nitrogenous base in the muscle increases with the age and size of the fish, and thus is higher in the older sea-living salmon than it is in the freshwater smolt.

Analyses are being made of the common inorganic ions in muscle from fish in freshwater and in sea water. Figures are insufficient at this moment for any general conclusions.

2. Growth of salinity tolerance

The experiments involved in this study were made at Stevenage, and it has not been possible to extend them because of the different temperature conditions of the experimental aquaria in the laboratory at Whitehall. The results will be published without further experimentation. A paper with the title "The development of salinity tolerance in salmonid fishes" is in the press for the *Journal of Experimental Biology*, Volume 37.

3. Histology of the gills

No further work has been done on this topic. A general discussion of the validity of the arguments for a salt-regulatory function for the acidophil (Keys-Willmer) cells in the gills has been published jointly with F. G. T. Holliday and J. H. Blaxter, Scottish Home Department, Marine Laboratory: Nature, Lond., 183: 1248-49, "Chloride secretory cells in the gills of teleosts".

4. Function of the pseudobranch

This experimental study (in conjunction with F. G. T. Holliday) has led to the conclusion that this organ is intimately concerned with colour change in fishes, and that it bears a special relationship with the choroid gland of the eye, and possibly also with the pituitary. The results of this study will appear in a paper in the Journal of Experimental Biology, Volume 37.

5. Vitamin A in salmon

A study of the distribution of the two isomers of Vitamin A in the different organs of the salmon, at different times in the life-history, is being made in conjunction with Dr. L. R. Fisher and Dr. S. Kon, National Institute for Research in Dairying, Reading.

Preliminary results indicate that both A₁ and A₂ are present in parr and smolts reared artificially on horse offal (and thus a source of A₁) or living naturally and feeding on insects, molluscs, etc. There is some indication of a drop in Vitamin A content in pre-migratory smolts. Adult fish netted in the spring from the estuary, just prior to their entry into fresh water for the spawning, upstream migration have high Vitamin A levels (both A₁ and A₂) and this concentration of the vitamin gradually decreases (along with the fat content of the fish) during its freshwater sojourn. The concentration remains fairly high, until spawning, but drops very sharply in the months following when the spent fish gradually drops back towards the sea. After being in the river for 6 months or so (during which time there is no evidence of feeding) the fat content of the fish, and its Vitamin A also, drops to only 1% of its pre-spawning level.

GWYNETH PARRY

German Salmon Fisheries in 1959

(Tables 1-4)

The yield of the German salmon fishery in the south-eastern part of the Baltic, rose again from 194 tons in 1958 to 243 tons in 1959. This increase was caused by good catches in the early months of the year. By the end of the fishing season, at the beginning of June, 157 tons = 64.4% of the annual catch was obtained, as against only 84 tons = 43.2% in the same months of the previous year. On the other hand, the months October/December 1959 yielded 86 tons (= 35.6%) only, against 110 tons (= 56.8%) in 1958. The fishing season 1958/59, yielding 267 tons, was the second-best since the beginning of the German salmon fishery in the central Baltic ten years ago, and was exceeded only by the season 1956/57 (375 tons). The regular shift between higher and lower salmon catches, pointed out in the last report, continues per season as well as per trip, as a consequence of the fluctuations in the salmon stock.

The size composition of the landings at the Kiel Fish Market in 1959 is given in Table 1.

Table 1.

Market category	I	II	III	IV	V	VI	Aver.
Gutted weight, kg	>8	7-8	5-7	3-5	2-3	1-2	weight kg
	Number (%)						
Jan./Febr.	6.9	7.1	11.6	51.1	21.2	2.1	4.21
March/April	8.1	9.3	14.7	48.4	18.1	1.4	4.48
May/June	3.4	4.2	7.6	72.2	11.6	1.0	3.92
Oct./Dec.	14.4	10.9	12.1	30.7	26.4	5.5	4.57
Total catch	9.4	8.8	12.5	44.9	21.5	2.9	4.39

The salmon is sorted now in 6 market categories, by dividing the former size-class II (5—8 kg) into two classes.

As was generally observed in recent years, the size composition of the autumn landings of 1959, at the beginning of the new season, was quite different from that of the spring at the end of the previous season. 1959 was characterized by an increase of the average weight of salmon, caused by the greater frequency of larger salmon (I—III) during the last months. The situation was the same as in 1957, and contrary to that of 1958 and 1956 when the percentage of large salmon decreased towards the end of the year. Thus the influence of the fluctuations in the stock of salmon upon the size composition and the catch was proved again in 1959.

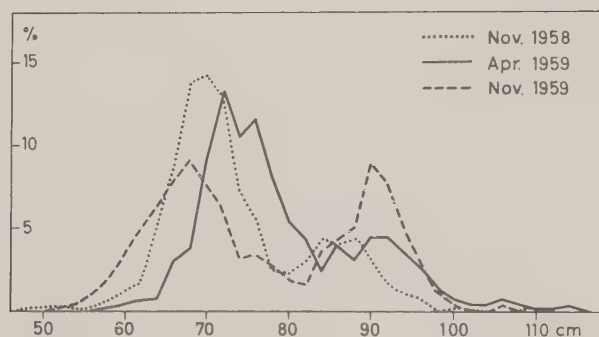


Figure 1. Length distribution of salmon landed at the Kiel Fish Market.

Obviously the new fishable 1958 year-class of smolt appearing in the catches during the autumn of 1959 mostly as 2.2 and 3.2 year-old fish, was remarkably less abundant than the preceding 1957 smolt year-class, as may be shown by the change in the size composition of the catches (Table 1) as well as by the length distribution (Fig. 1). The differences in the frequency of the year-classes become evident when we consider the two size groups which in the frequency curve are marked by two peaks and a minimum at about 80 cm separating the majority of the salmon in the second winter from those in the third winter. From the weight of the total landings and the length measurements at the Kiel Fish Market, the data given in Table 2 were calculated, which indicate the extent of the fluctuations in the smolt production.

Table 2. Number of salmon caught by German fishermen in the periods January/June and October/December 1956/59
Total catch >80 cm <80 cm

		>80 cm	<80 cm
October/December 1956 ..	43,600	34,900	8,700
January/June 1957	49,260	39,900	9,360
October/December 1957 ..	32,280	17,100	15,180
January/June 1958	17,420	9,760	7,660
October/December 1958 ..	26,100	16,700	9,400
January/June 1959	36,400	25,500	10,900
October/December 1959 ..	18,930	11,790	7,140

Though the number of salmon below and above 80 cm are only a rough approximation to the proportions of the two most important marine age groups in the catches, this first attempt to estimate their quantities is very instructive. We may presume that the fishery intensity was nearly equal in the years under consideration. The number of smaller salmon caught in Oct.—Dec. 1959, was only two-thirds of that obtained in the same months one year before. In the season 1958/59 the total number of this smaller size group amount-

ed to 42,000; only a little more than half of this quantity may be expected in the present season 1959/60. In the preceding seasons the approximate numbers for the A. 2 year-old salmon in German catches were 27,000 (1957/58) and 75,000 (1956/57) indicating the great fluctuations in the smolt production in the period 1955/1958.

Age determinations carried out by Fr. THUROW in January 1958 and 1959, confirm these estimations of the relative strength of the 1956 and 1957 smolt year-classes. If the catch per 10 commercial trips in December/January is taken as unit effort, the numbers set out in Table 3 of salmon of the different age-groups result.

Table 3.

Dec./Jan.	Total	Age-groups				
		A.1	A.2	A.3	A.4	A.5
1957/58	1,360	4	737	530	78	11
1958/59	2,130	20	1,540	512	50	8

The greater catches in 1958/59 were caused mainly by the greater frequency of salmon passing the second winter in the sea which was nearly twice as compared with that in 1957/58 (1956 and 1955 smolt year-classes). From the total yields in the fishing seasons the ratio 1 : 1.5 was calculated (Table 2).

The results of such a calculation vastly depend on the catch per unit effort chosen as basis. According to the records in the diaries kept by fishermen, the average catch per 1,000 hooks was 13.7 salmon in December/January 1957/58, and 26.4 in the same months 1958/59. This comparison suggests the doubling of the salmon stock within that year and leaves us with a ratio 1 : 2.6 for the age-groups in question. Opposite to trawling for demersal fish, in hooking for pelagic fish as salmon the catch per unit effort (1,000 hooks) is influenced not only by the density of the stock, but also by some factors determining the behaviour of the fish, especially as far as the liability of the fish to take the bait is concerned. Therefore the following attempt to calculate the total mortality and loss by migration from the data given in Table 3 may be regarded with reservation. According to these, age-group A. 2 decreased to A. 3 by 30% in number, and age-group A. 3 to A. 4, as well as A. 4 to A. 5, diminished by 90%. As the main losses by the spawning migration occur after the third winter in the sea, the values for the older age-groups seem to be acceptable. For the exact calculation of the losses during the second winter and the following spring and summer, we need further data.

With regard to the total age of the salmon and the frequency of the fry year-classes, the following numbers per 10 commercial trips in December/January are obtained from scale reading:—

Year-class	1957/58		1958/59	
	Number	%	Number	%
1956	—	—	78	3.6
1955	34	2.5	486	22.8
1954	228	21.2	904	42.4
1953	672	49.5	557	26.2
1952	300	22.0	83	3.9
1951	59	4.3	23	1.1
1950	7	0.5	—	—
Total	1,360	100	2,130	100

Six year-classes were present in the catches, and in both fishing seasons the majority was formed by 4—6 year-old salmon, the age-group V being the most frequent one. The 1953 and 1954 year-classes were unequally represented as V-group, the 1954 year-class being more frequent in 1958/59 though lower in percentage than the preceding 1953 year-class, owing to the greater total catch. The difference would be still much larger, if we calculate the number for each year-class according to the catch per unit effort mentioned above.

In order to obtain exact information on the strength of the year-classes and the annual losses by natural mortality, fishing mortality, and spawning migration, numerous age determinations of salmon caught in the sea must be carried out in succeeding years, and reliable data for catch per unit effort as a basis for the calculation must be found.

For completion of this survey the quantities of each market category landed at the Kiel Fish Market during the two last years are given in Table 4.

Table 4. Salmon landed at the Kiel Fish Market in 1958 and 1959 (in tons)

Market category	I	II	III	IV	V	VI	Total
Jan./June 1958 ..	19.1	12.0	11.2	16.0	8.0	1.0	67.3
Oct./Dec. 1958 ..	8.3	11.0	15.2	35.4	9.4	0.4	79.7
Jan./June 1959 ..	18.7	16.3	21.3	52.5	13.9	0.7	123.5
Oct./Dec. 1959 ..	16.1	10.0	9.1	13.5	8.0	1.1	57.8

Whereas the fairly good 1957 smolt year-class (age-group A. 2) caused a considerable increase especially of market category IV (formerly termed III) in the first months of 1959, the weak 1958 smolt year-class yielded small quantities only in the last months (size group IV—V), and the stock of older salmon (I, II, partly III) though including a rich year-class, was too small to compensate for the deficit of smaller fish.

On account of the results of our investigations it may be predicted that the fishing season 1959/60 will give a much lower yield than the preceding one, and the total catch to be expected in 1960 will depend on the frequency of the 1959 smolt year-class. As these data are still unknown, all efforts must be made at an early date in order to obtain knowledge of this very important factor.

R. KÄNDLER

Food Investigations on Salmon and Sea Trout in South-Eastern Baltic

(Table 5)

In spring 1959 the contents of stomachs of 65 drift-net caught salmon were analysed. The total weight of the fish was 407 kg. Among the analysed specimens there were 11 (31 kg) only, whose stomachs were empty. The mass of stomach content of all fish examined was the following: Clupeidae, 4,807 g; *Ammodytes* sp., 37 g; and *Gasterosteus* sp., 4 g. Of invertebrates only an unimportant quantity of crustaceans of *Gammarus* sp. was found in the stomachs.

In the autumn and winter seasons of 1959/60, 118 specimens of salmon (626 kg) were examined. They were hooked by means of drift-lines. In the total catch there were 25 salmon (131 kg) with empty stomachs. The food of these salmon was more diversified than during the spring season but the ratio of food intake per fish was relatively poorer. The mass of fish found in the stomachs of salmon consisted of: Clupeidae, 1,934 g; *Belone belone*, 355 g; *Gadus callarias*, 227 g; *Rutilus rutilus*, 126 g; *Salmo* sp., 100 g; *Ammodytes* sp., 47 g; *Gasterosteus* sp., 5 g and only a small quantity of crustaceans, such as *Gammarus* sp., *Mysis mixta*, *Crangon crangon*, *Mesidothea entomon*, and *Pontoporeia femorata*, was found.

During 1959, 63 sea-trout specimens, weighing 243 kg, were examined. Among the total number, 36 specimens (133 kg) had empty stomachs. The sea trout were caught in the inshore waters and in the estuaries of rivers which the fish enter to spawn. Hence, probably the relatively considerable number of fish with empty stomachs. The food composition of the sea-trout according to our analyses, was as follows: Clupeidae, 492 g; *Belone belone*, 39 g; *Ammodytes* sp., 4 g; *Gobius minutus*, 1 g. The Crustacea occurred in considerable numbers, the predominant species being *Crangon crangon*, 33.5 g, and only a negligible quantity of *Gammarus* sp. and *Mysis mixta*.

Table 5. Percentage of salmon and sea trout containing food organisms

	Salmon (spring)	Salmon (autumn/ winter)	Sea trout (whole year)
Clupeidae	76	60	29
<i>Belone belone</i>	—	15	3
<i>Gadus callarias</i>	—	7	—
<i>Rutilus rutilus</i>	—	5	—
<i>Ammodytes</i> sp.	5	4	2
<i>Salmo</i> sp.	—	1	—
<i>Gasterosteus</i> sp.	3	4	5
<i>Gobius minutus</i>	—	—	2
<i>Crangon crangon</i>	—	1	11
<i>Gammarus</i> sp.	9	5	6
<i>Mysis mixta</i>	—	3	2
<i>Mesodotea entomon</i> ..	—	1	—
<i>Pontoporeia femorata</i> .	—	1	—
Empty	17	21	57

Both the food content found in the stomachs and the data recorded in Table 5, show that the salmon and sea trout feed mainly on Clupeidae. Owing to the difficulty in distinguishing the partly digested herring and sprat these two species have been placed into one group, namely, that of Clupeidae. However, the results of analysis of this undigested foodstuff indicate that in spring the salmon feed only slightly on sprat. In autumn and

winter, in the portion of Clupeidae distinguishable for both the species, the proportion of sprat was scarcely 5%. Hence, it may be concluded that herring constitutes the basic food of salmon of the south-eastern Baltic regions. Quite a substantial share in the food of salmon, in inshore waters, appears to be garpike and, in a lesser degree, the sand-eel. Other species seem to constitute an occasional food only. Thus, for instance, in winter, owing to cold surface water, the salmon feed in deeper regions on small-sized cod. Roach of the Puck Bay waters, where it occurs plentifully, is also known to be fed upon by the salmon. It has also been observed that salmon feed willingly on roach baited on hooks.

As regards the food of sea trout, the data obtained can only be considered as approximate owing to insufficient material.

It seems that during the life in the sea of sea trout the herring also constitutes its basic food. It is also assumed that *Belone* and *Crangon* constitute an additional food of this fish. The role of other fish and crustaceans in the food intake, both of sea trout and of salmon, can only be determined when greater quantities of fish of different size have been examined.

K. WIKTOR

Shellfish

CRUSTACEA

Unusual Abundance of Whiting in the German Shrimp Catches of 1959

(Table 1)

In 1959, the total landings of the German shrimp fishery amounted to 37,696 metric tons. 4,414 tons of these were edible shrimps, 21,284 tons industrial shrimps, and 11,998 tons industrial fish and crabs. The shrimp catch of 25,698 tons was the lowest since 1952. As during previous years the catch composition was studied. 315 random samples each of 5 kg were collected in Wyk on Föhr, Büsum, Cuxhaven, Varel, Neuhaulingersiel, and Norddeich and were analysed as to their species composition. This research reveals for 1959 an abnormal abundance of whiting in the coastal waters which may have a bearing on the fact that shrimp catches have been very low since it is known that whiting can considerably reduce the stock of shrimps by feeding on them (1). Table 1 shows that the number of whiting in the shrimp catches was 5 to 30 times higher in 1959 than in previous years. The reason for this unusual abundance is not clear at present. It may be that the abnormally rich year-class

Table 1. Whiting in the German shrimp catch

	1954	1955	1956	1957	1958	1959
Weight in tons	65	58	301	234	152	967
Number (mil. fish)	3.06	3.86	8.96	22.63	9.02	109.14

of 1959 moved into the coastal waters. But it is possible also that the abnormally high salinity found in coastal waters due to the very dry year, has attracted the whiting population — mainly belonging to the 0-group — into the fishing area which was found in previous years to be by 4–6‰ lower in salinity than in 1959.

Investigations are on their way to assess the total loss of shrimp stock and its yearly fluctuations caused by the predatory fishes.

P. F. MEYER-WAARDEN
and K. TIEWS

Reference

- (1) GILIS, CH., 1952. "La pêche crevettière sur la côte belge: son évolution au cours des années 1935–1951 et son influence sur le stock de la crevette". Inst. Etud. marit., Ostende, Mém. No 8.

MOLLUSCA

1

Oyster

Larvae and Spatfall of Oysters in the Oosterschelde (Netherlands) in 1959

(Figure 1)

Though mussel shells become a more and more important collector in the Zealand oyster industry, which involves a gradual decline in the number of tiles used, spatfall prediction has been continued in 1959.

The methods used in collecting samples of 100 litres of water and in counting and measuring the larvae in such samples have been described previously. The samples were again collected at the Yersche Bank station, in the centre of the basin of the Oosterschelde. Since incubating oysters were already observed late in May, and appeared to be quite numerous early in June, it was decided to begin plankton sampling earlier than usual. Daily

samples were taken at high slack water from 9. up to 20 June inclusive; twice-daily samples, at high slack water and low slack water, in the height of the season from 22. June to 4. August inclusive. From 6. to 31. August samples were collected at high slack water only. It was impossible to collect plankton samples on Sundays when the boats stayed in port. When two samples were taken a day, the average number of larvae of each size class has been computed for 100 litres, and is depicted in the diagram (Figure 1). The intensity of setting was measured in the usual way by exposing 3 lime-coated glass slides, measuring 13 x 18 cm, at an angle of 45° in a concrete container, for periods of 3 days. The average number of spat per slide is shown in the diagram. The average number of barnacles found on 10 cm² of the slides (5 cm² upper plus 5 cm² lower surface) has also been depicted in the diagram.

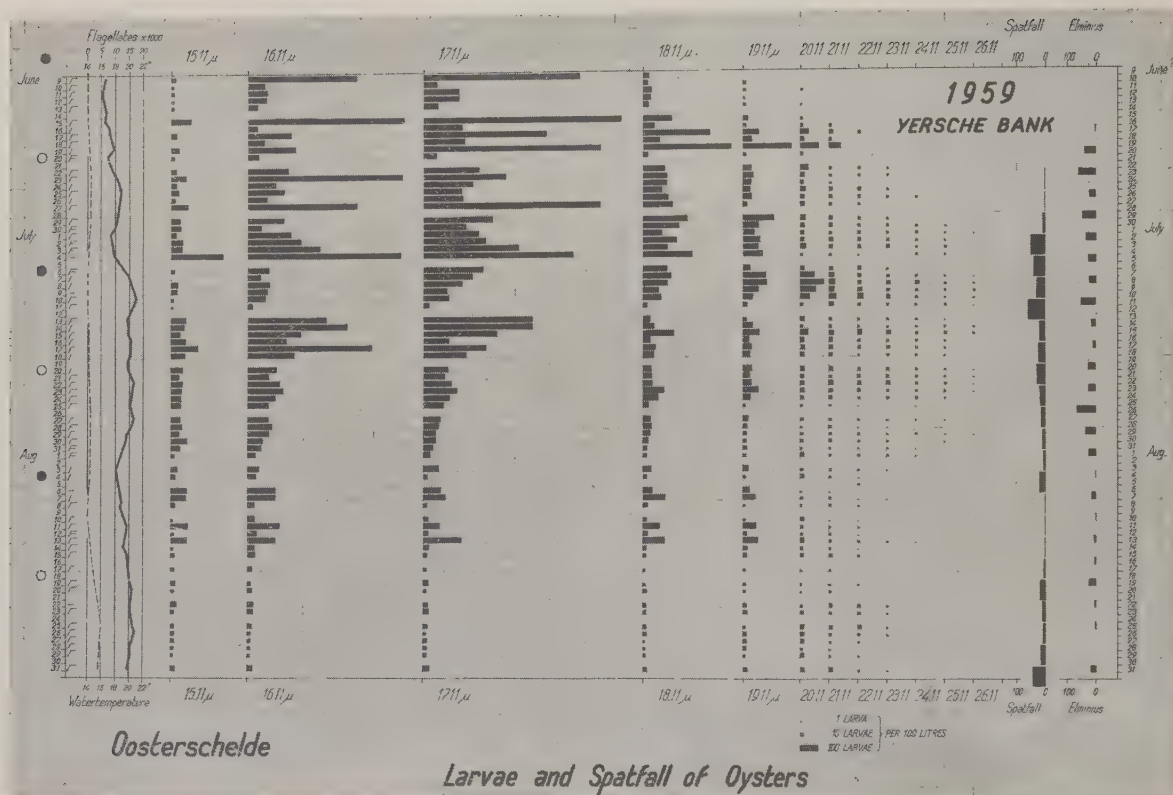


Figure 1.

Again, it was predicted that the total number of larvae would be so great that only continuously adverse conditions would lead to an insufficient number of spat on the collectors. Winter and spring temperatures had been above the average: January water temperatures were 3.6°C higher than usual, February temperatures, on the other hand, were 1.5° lower than usual, but those of March again 2.2° above the average, April 1.6° , and May 0.8° . The first half of June was normal with a water temperature of 16.5°C , the second half some 0.8° above the average of 17.3°C . Still it is rather surprising that these higher spring temperatures led to an unusually early beginning of swarming. Experience gained in a great number of years shows that the Zealand oysters tend to stick closer to the calendar than to the actual water temperature in commencing their spawning.

The first bulletin, issued 11. June, informed the oystermen that some 200 larvae did already occur per 100 litres of water that early. Water temperatures still being below the 17°C level at that time, a favourable development could not be expected. On 17. June it was said that the number of larvae remained at about the same level, and that notwithstanding

the low water temperatures at that time some larvae did reveal growth. On 22. June a further increase in the number of larvae was recorded but water temperatures still being rather low, spatfall could not yet be anticipated. On 24. June a further increase in the number of oyster larvae to over 1000 per 100 litres of water was stated. Since the water temperature had passed the 18°C level, better growth could be expected, and the very first spat was announced for the end of that week. On 30. June the water temperature was said to be a little over 18°C , so that larval development could proceed quite satisfactorily. "Umbo" larvae being observed, spatfall of some importance could soon take place. On 4. July a drop in water temperature to about 17.5°C was recorded, but the number of grown larvae and "umbo" larvae still being rather high, a spatfall of commercial importance was announced. Better weather and better larval development were recorded in the bulletin of 9. July. Setting of considerable importance was predicted for that period and for the days to come.

A decline in the number of larvae was stated in the bulletin issued 15. July. "Umbo" larvae still being present in fair numbers, spatfall of some

importance could still be expected. On 21. July high water temperatures were said to prevail. The number of larvae still being over 500 per 100 litres of water, and "umbo" larvae still being observed, spatfall was said to continue, be it on a rather modest scale. A declining number of oyster larvae was recorded on 28. July, together with a decline in the number of large and "umbo" larvae, so that the outlook for spatfall became rather unfavourable. A further decline in the number of oyster larvae and further deterioration of spatfall prospects was broadcast on 6. August. Since further plankton analysis did not reveal any amelioration of the prospects, no further bulletins were issued.

The diagram (Figure 1) reveals that the total production of larvae was great indeed, and surpassed that of the year 1958, as could be expected considering the size of the oyster stock and the favourable water temperatures in spring and early summer. Very unusual was the early appearance of appreciable numbers of oyster larvae. It is exceptional, even after warm spells, to find large numbers of oyster larvae prior to 20. June. The vast majority of the oyster larvae made their appearance in 1959 between 15. June and 15. July, without very clear-cut peaks, though the days immediately following full and new moon showed a reduced production of larvae, in accordance with the lunar periodicity pattern. After 19. July the larval production levelled off very clearly. The early onset of swarming in 1959 evidently led to an early reduction of spawning activities in a fair percentage of the adult oysters.

Considering the huge number of larvae produced and the fairly reasonable water temperatures, one would have expected somewhat greater numbers of large and "umbo" larvae than were actually observed. Evidently larval development has not been very good in this year. When one takes into consideration the number of flagellates counted per cm³ of water, it is clear that feeding conditions must have been less favourable than in preceding years. Even 1958 revealed, with the exception of the first half of July, higher flagellate numbers. Figures over 2000 per cm³ were not observed in late June or in July 1959, which contrasts unfavourably with preceding years. After 15. August the number of flagellates rose quite considerably, but the number of oyster larvae being very modest at that time, no practical results were expected. There were, however, many more large oyster larvae late in August than one would expect from the very modest number of young larvae which made their appearance in the water.

Setting on lime-coated glass collectors was first observed in the period 21. to 24. June, be it in small numbers. At the end of that month the setting intensity went up steeply and excellent setting took place from 1. July to 13. July. Reasonable numbers of spat, indicating a spatfall of commercial importance, were counted for the period 13. July to 22. July, commensurate with the fair numbers of "umbo" larvae observed at that time. Thereafter the spatfall intensity decreased. A slight increment early in August, not reflected in a larger number of "umbo" larvae, is rather remarkable. Very unusual is an appreciable setting after 18. August with even an important peak at the very end of that month. This has not been observed since the observations were begun in 1936! Very peculiar is that "umbo" larvae have not been observed in the samples collected after 15. August, and that the spatfall could nevertheless reach an appreciable level. Evidently samples of 100 litres of water are not large enough to be a reliable measure for low intensities of setting; or, in other words, even when less than 1 "umbo" larva occurs in 100 litres of water some spatfall may occur on clean collectors measuring 13 x 18 cm.

Commercially the spatfall season was a success in 1959. The bulletins facilitated timing of the placement of tile collectors, so that it was possible to make use of the excellent setting conditions in the first 12 days of July. Most tiles carried over 100 spat late in the year. Mussel shells, scattered on deeper plots late in June or in the very first days of July, offered a good substratum for many oyster larvae. The winter of 1959—1960 was mild, but still quite a high percentage of the spat on mussel shells died. The cause of this premature death has not been ascertained.

Barnacles showed a diffuse peak of setting from 19. June to late in July. In total more barnacles settled than in previous years, but still the oyster spat on the tiles found space enough to develop.

P. KORRINGA

The Quality of Oysters in Relation to Environmental Conditions in the Oosterschelde in 1959

(Figures 2—14)

Description of the research

Again, as in 1957 and 1958, observations have been made on the development of oysters in the western and eastern section of the Oosterschelde.

In the second part of the year, the index of condition has been determined on a weekly basis, whereas throughout the whole year considerable attention has been paid to the complex of ecological



Figure 2. The Oosterschelde.
xx = sampling stations. AB = oyster sampling plots.

factors which affects growth and condition of *Ostrea edulis* in this arm of the North Sea, situated in the southern part of the so-called Dutch Delta Estuary (Fig. 2).

The monthly averages of several hydrographical, meteorological, chemical, and biological observations have been computed. Some of these are presented in the graphs. These data serve as background information. In the discussion below special attention is paid to those ecological factors which have a direct influence on the life of the oysters.

The site of the stations and plots, as well as the methods of sampling and analysing water and oysters, have been described previously.

Salinity

At both the stations Zieriksee and Yerseke the differences observed between the salinities at H.W. and at L.W. were slight. The yearly average at the station Zieriksee amounted to 29.3‰ , at the station Yerseke to 29.2‰ . In the winter months January, February, March, April, November, and December the averages were 28.8 and 28.4‰ for the two stations respectively, whereas for the summer months averages of 29.8 and 30.0‰ have been computed.

The marked drop in salinity to 25.4‰ early in the year was first observed in the western section

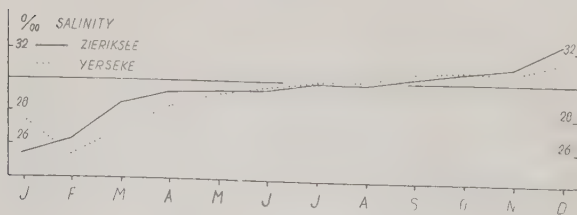


Figure 3. Salinity in 1959.

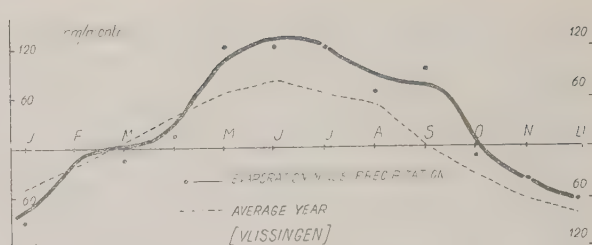


Figure 4. Evaporation minus precipitation in 1959 and in an average year.

and made itself felt about one month later in the eastern section. (Fig. 3.) This salinity minimum was brought about by a precipitation peak in the months of December 1958 and January 1959, at temperatures well above the freezing point. On the whole, the fluctuations in the salinity can be considered a retarded consequence of meteorological conditions in a very wide area around the Delta-system. The dry summer of 1959 impressed its mark on the salinity pattern; local precipitation figures are of minor influence only. Figure 4 reveals that the higher salinity in the station Yerseke, from July to October, as compared with the station Zieriksee, should be ascribed to a greater evaporation in the eastern section of the Oosterschelde, with its extensive shallows and sand bars.

The yearly average of evaporation minus precipitation amounted to $+26$ mm (normal $+3$ mm); the average in the winter months to -32 mm (normal -29 mm) and in the summer months to $+84$ mm (normal $+35$ mm).

Temperature and radiation

The yearly averages of the water temperature at the stations Zieriksee and Yerseke were 11.6 and 11.5°C respectively. In the winter months the averages were 6.0 and 5.7°C ; in the summer months 17.2 and 17.4°C .

During three of the summer months the water temperature at the station Zieriksee surpassed the 18°C level. At the station Yerseke, on the other hand, the water temperature came above the 18°C level in two months only, but in one of those the average figure surpassed 20°C (Fig. 5). These high temperatures, especially those in the month of July, favoured the outbreak of shell-disease among young oysters in the easternmost part of the Oosterschelde, especially where the plots had not been cleaned regularly.

The metabolic activity of the oysters was high till early in November, which favoured the fattening of the oysters, especially in the eastern section.

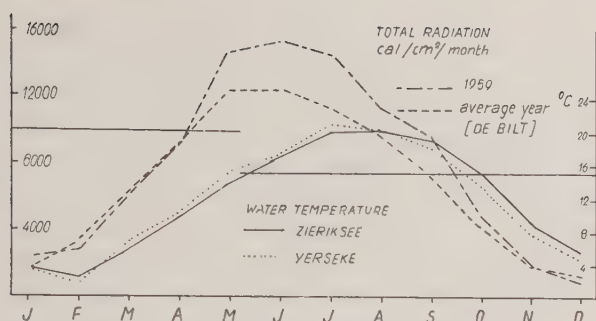


Figure 5. Total radiation and water temperature.

The course of the water temperature was in close correlation with the total solar radiation, which was above normal from May to November, (Fig. 5). The very clear water in both sections of the Oosterschelde, in combination with the high radiation figures, may have exerted an influence on the relative chlorophyll content of the phytoplankton organisms. It is presumed that the quantity of chlorophyll will have been low in many phytoplankton species in the summer of 1959. The maximum quantity of radiation per month amounted to 15,347 cal/cm² in June (12,362 cal/cm² being normal). That the radiation still amounted to 4,732 cal/cm² (4,312 cal/cm² being normal) in October will certainly have contributed to continuation of the second phytoplankton bloom until November.

Phytoplankton

Determination of the chlorophyll content in the fractions net plankton, larger nanoplankton, and smaller nanoplankton, gave an idea of the quantitative fluctuations within these phytoplankton categories. The relative graphs can be compared with a graph of the chlorophyll content in the total plankton (Figs. 6 and 7).

Broadly speaking, this year revealed again the pattern of two plankton blooms. Grazing by herbivores, as well as an increasing shortage of nutrients, depressed both phytoplankton blooms in due course. Many days of calm weather will moreover have favoured the activities of filter feeders. Peculiarly enough, the outburst of the first phytoplankton bloom in March did not lead to a faster decrease in nutrients at the station Yerseke, with its very high content of plankton chlorophyll, than at the station Zieriksee, where the phytoplankton bloom was of a more modest nature. It is assumed that the high chlorophyll figures in the eastern section, especially for the net plankton, should at least partly be ascribed to swirling up of bottom material. In

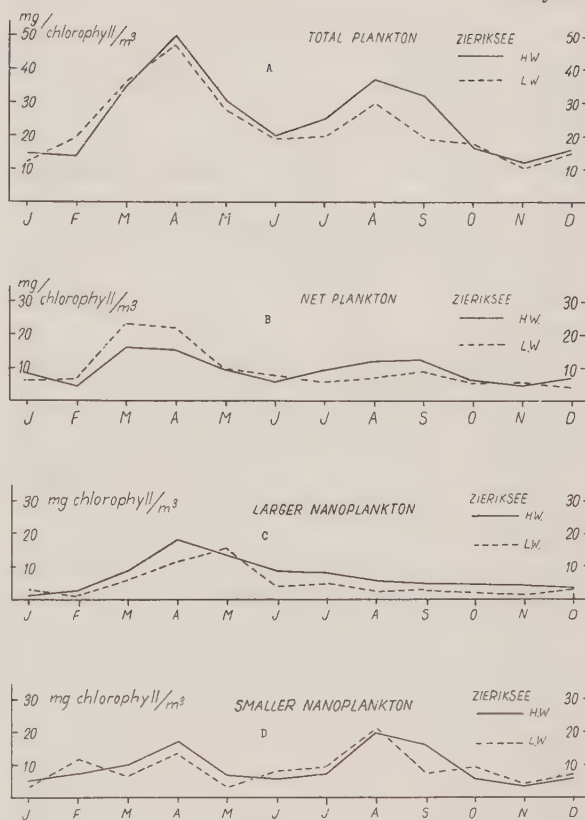


Figure 6. Phytoplankton at Zieriksee. (A) total plankton; (B) net plankton; (C) larger nanoplankton; (D) smaller nanoplankton.

March bottom-living diatoms were seen quite frequently in the samples, sometimes even in clusters, and these diatoms contain a relatively high content of chlorophyll per cell. The second phytoplankton bloom, in late summer and autumn, and of more importance for the fattening of the oysters, yielded higher chlorophyll figures for the western section. This was due to a higher content of net plankton, which apparently penetrated the Oosterschelde from the sea. Conditions seem to favour the development of nanoplankton organisms in the eastern section, where the water is clearer and shallower, but where, on the other hand, the grazing by bottom living filter feeders is greater.

Usually the low water temperatures hardly allow the oysters to profit from the spring phytoplankton bloom, but sometimes they feed actively towards the end of the bloom. We know that especially a variety of smaller phytoplankton organisms is good oyster food. In May 1959 the larger nanoplankton was abundant in the western section, whereas smaller nanoplankton organisms abounded in the

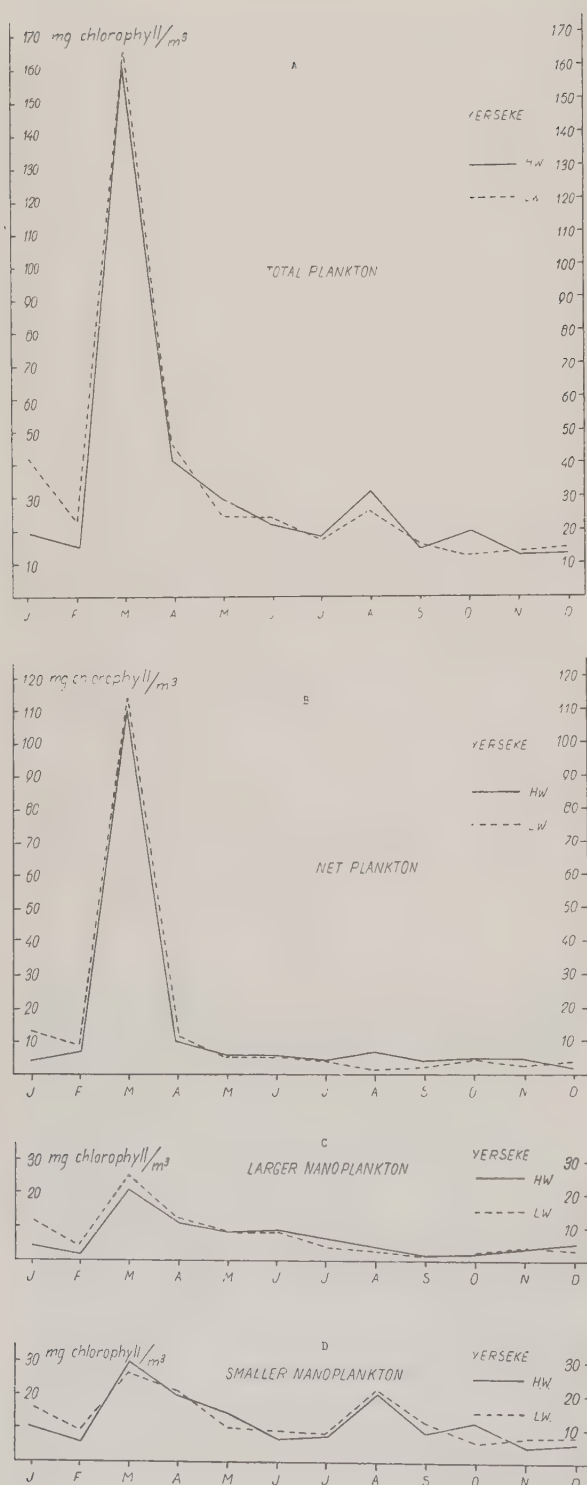


Figure 7. Phytoplankton at Yerseke. (A) total plankton; (B) net plankton; (C) larger nanoplankton; (D) smaller nanoplankton.

eastern section at that time. Recuperation of the oysters after the spawning period was based on consumption of the abundant smaller nanoplankton organisms of the late summer and autumn bloom.

The yearly averages of the chlorophyll content of the total plankton amounted at the station Zieriksee H.W./L.W. and at the station Yerseke H.W./L.W. to 25.25/22.7 and 33.2/35.3 mg per m³ respectively. In the winter months the average amounted to 23.5/23.1 and 43.9/50.7 mg per m³, in the summer months to 27.0/22.3 and 22.5/19.9 mg per m³, respectively.

In the same order the net plankton reveals the following averages per year: 9.2/9.2 and 14.25/14.7, winter months 9.0/11.1 and 23.1/25.5, and summer months 9.4/7.3 and 5.4/3.9 mg per m³.

The averages of the chlorophyll content of the larger nanoplankton were, for the year: 6.95/4.75 and 6.65/7.5, in winter months 6.4/4.3 and 7.9/10.4, and summer months 7.5/5.2 and 5.4/4.6 mg per m³.

The averages for the smaller nanoplankton were for the year: 9.1/8.75 and 12.3/13.1, in winter months 8.1/7.7 and 12.9/14.8, and summer months 10.1/9.8 and 11.7/11.4 mg per m³.

All the summertime averages correspond very well with the 1958 averages. That the wintertime averages were higher, in the eastern section, is ascribed to whirling up of the bottom material. Again, the stock of the smaller nanoplankton organisms revealed a higher level per unit of water in the eastern than in the western section of the Oosterschelde.

Flagellates

Flagellate figures were low in 1959 (Figs. 8 and 9). The yearly averages per cm³ at the stations Zieriksee H.W./L.W. and Yerseke H.W./L.W. were computed as 1,575/1,250 and 1,450/1,525, respectively. In the winter months the averages were 1,600/1,400 and 1,400/1,600, in the summer months 1,550/1,100 and 1,500/1,450 flagellates per cm³, respectively.

Partly the ups and downs ran parallel with the fluctuations in the quantity of smaller nanoplankton organisms for which the chlorophyll-containing flagellates only can be held responsible. Sometimes, peaks in the number of pigmented flagellates are closely followed by a bloom of colourless heterotrophic species. This was observed in the month of May in the eastern section. The retarded decline of the smaller nanoplankton organisms at the station Yerseke in May should be ascribed to an infiltration by new small nanoplankton species from the western section and not to an abundance of chlorophyll-containing flagellates.

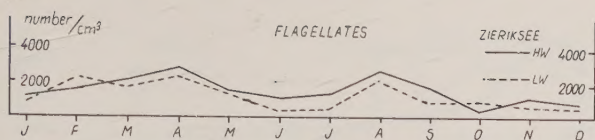


Figure 8. Flagellates, Zieriksee.



Figure 9. Flagellates, Yerseke.

The low figures for colourless flagellates are partly associated with a lack of suitable food-material caused by the dry year and the reduced run-off from the land. On the other hand, the activity of the numerous copepods in the prolonged period of high water temperatures, and of a variety of other filter feeders, shellfish larvae included, must have led to a rapid grazing down of the flagellate populations. This phenomenon was especially evident in the eastern section, where the peaks of flagellates were always of shorter duration than in the western section.

Dry weight of suspended matter

The yearly averages of the total particulate suspended matter at the stations Zieriksee H.W./L.W. and Yerseke H.W./L.W. amounted to 17.1/14.05 and 7.9/9.6 mg per litre, respectively. For the winter months the figures amounted to 24.0/19.5 and 10.1/13.3 respectively, for the summer months to 10.2/8.6 and 5.7/5.9 mg per litre (Fig. 10).

At temperatures above 10°C calm weather favoured the growth of the oysters, no clouds of silt hindering them in their filtering activities. In June, July, and August the silt content was very low at the station Zieriksee. In the western section

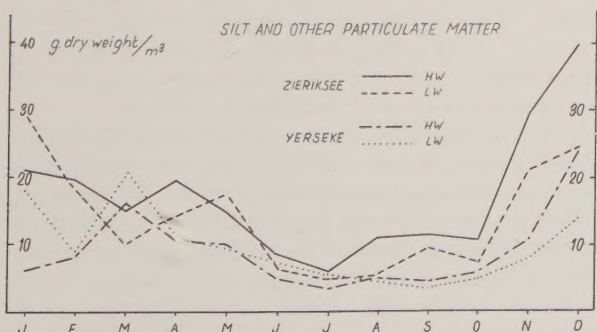


Figure 10. Silt and other particulate matter.

growth was best in the first half of August, but already in June some shell growth could be observed. In the months of May, July, August, and September the monthly averages of suspended matter at the station Yerseke amounted to 9.9, 4.6, 4.8, and 3.9 mg dry weight per litre, respectively. In the eastern section growth was best late in August and in September, whereas in May and also in the second part of July shell shoots were made to some extent. The thickening of the new shell-rims is a more continuous process.

In most cases the course of the turbidity figures resembled closely those of the dry weight of suspended matter. This means that, in 1959, turbidity was predominantly brought about by particulate matter and not by other material, such as, e.g., humic substances. The greatest turbidity was observed in winter at the station Zieriksee at H.W. and the clearest water in summer at station Yerseke at L.W. Still the water in the eastern section of the Oosterschelde was in March more turbid than that in the western section, but this corresponds with the dry weight of suspended matter. Both the luxuriant phytoplankton and the material swirled up from the bottom led to these high figures in March.

Wind speed

Without doubt wind has an effect on the figures for suspended matter and turbidity. That also the chlorophyll figures can be directly influenced by wind, as was observed in the eastern section in January and March (Fig. 11), has been discussed above.

The graph depicting wind speeds reveals how much calm weather there was in 1959. This will have had considerable influence on the total system of production and consumption of food. It is assumed that prolonged calm spell in the months

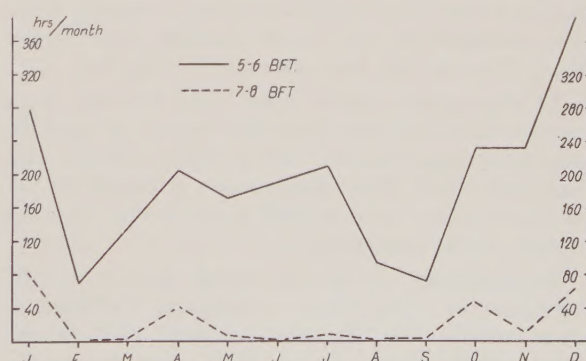


Figure 11. Wind speed at the coast of Zeeland.

of August and September favoured growth and fattening of the oysters after the long period of reproduction.

Acidity and specific alkalinity

The differences in pH between the stations Zieriksee and Yerseke, so remarkable in previous years, were of considerably less importance in 1959. It was in March, during the bloom of phytoplankton, that the pH at the station Yerseke rose from 7.39 to 8.21. In April the monthly average was 7.98. In the summer months the average was 8.06 with a maximum in September of 8.19, which figures closely approximate to those for the station Zieriksee in 1959 and previous years.

An increased discharge of carbon dioxide in spring is a factor which may have contributed to the shifting of the pH in the eastern section of the Oosterschelde. But a factor which should not be overlooked is the alkalinity or buffer-capacity of the sea water, and especially the presence of bicarbonates, to form a complex buffer-system with a pH of about 8. In February the specific alkalinity at the station Yerseke was higher than at Zieriksee, viz. about 0.194 and 0.184 respectively, which can be ascribed to the lower salinity at that time. The lower the salinity, the more calcium carbonate can be in solution.

The yearly averages of the pH at the stations Zieriksee H.W./L.W. and Yerseke H.W./L.W. were 8.065/8.065 and 7.925/7.890, respectively. The seasonal differences followed the same pattern as in the foregoing year.

The yearly averages of the specific alkalinity at the stations Zieriksee H.W./L.W. and Yerseke H.W./L.W. were 0.163/0.163 and 0.162/0.163, respectively. The averages for the winter months were 0.168/0.167 and 0.169/0.171 respectively, and for the summer months 0.158/0.159 and 0.156/0.156. The seasonal differences of the specific alkalinity followed the same pattern as in the foregoing year. The averages for the winter months were higher than those for the summer months (Fig. 12).

In the regions where many shell bearing organisms absorb calcium from the water, the specific alkalinity was reduced, but a higher salinity also had that effect. This phenomenon is clearer in the shallow eastern section than in the deeper western section of the Oosterschelde.

Summarizing, it can be stated that a specific alkalinity of 0.163 (yearly average at Zieriksee) is characteristic for the best balanced part of the Oosterschelde, close to the North Sea. A specific alkalinity of 0.162 is typical for the region where

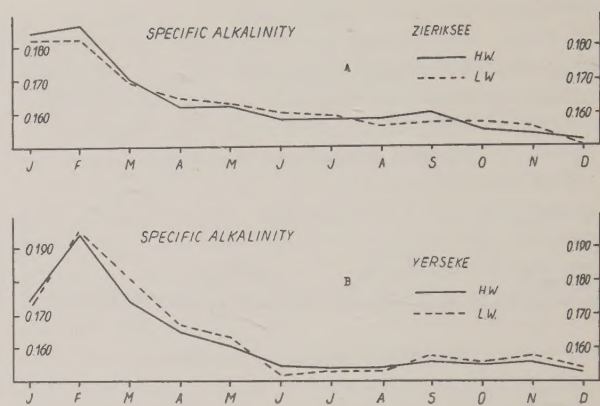


Figure 12. Specific alkalinity. (A) at Zieriksee; (B) at Yerseke.

mussels and oysters are relaid, whereas a specific alkalinity of 0.163 is recorded for the shallow eastern-most region where shell grit covers the bottom in many a place, since considerable quantities of rapidly disintegrating mussel shells are scattered here as collectors for oyster spat.

It was observed that the greatest fluctuations occurred in the eastern section of the Oosterschelde, the centre of oyster culture. More detailed information on the calcium exchange could throw new light upon the correlation between fluctuations in specific alkalinity and the periodicity of shell growth.

Quality of oysters

The investigations on the quality of oysters, in particular on "fattening", the accumulation of reserve material like glycogen etc., the data of which are expressed as the condition index, were begun earlier than in the previous year. At that time the spawning season had already begun and the reserve material was used on a large scale for the development of eggs and sperm.

In both the western and the eastern sections of the Oosterschelde spawning came virtually to an end early in August. At that time the condition index of the oysters in the western section, in the vicinity of the station Zieriksee, had dropped to 59.5, whereas it did not sink below 73.4 in the eastern section, near the station Yerseke.

That at both stations two samples revealed higher index figures in the middle of the spawning season does not indicate a general interruption of spawning (Figs. 13 and 14). It so happened that these samples were devoid of oysters incubating eggs or larvae. Much larger samples would be required if one wished to eliminate such fluctuations due to accidental absence or occurrence of incubating oyster during the spawning season.

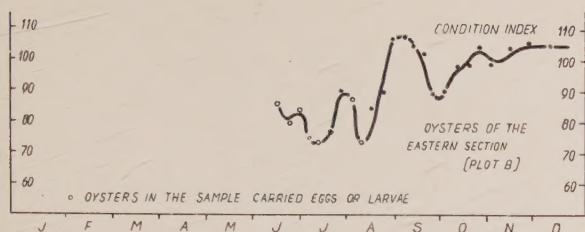


Figure 13. Oyster quality. Eastern section.

It so happened that early in August, when spawning was virtually over and the period of recuperation began, the second bloom of phytoplankton, mainly brought about by smaller nanoplankton organisms, developed. This facilitated a steep increase of the condition index. Early in September, when the marketing of oysters begins, the condition index in the western and eastern districts amounted already to 105.0 and 107.6, respectively. But at that time water temperatures were still high, about 18°C, and food was becoming scarce. In the metabolic processes catabolism soon prevailed over anabolism, resulting in a lower condition index at the end of September. This phenomenon was especially clear in the eastern section of the Oosterschelde, where food was scarcer than in the western section.

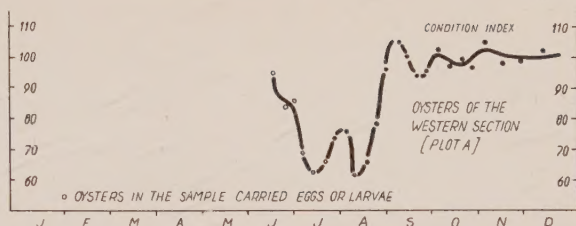


Figure 14. Oyster quality. Western section.

Condition indices dropped to 95.7 at Zieriksee and to 89.5 at Yerseke. Lower water temperatures in October and better feeding conditions led to recovery. The minor fluctuations later in the year are probably within the range of the errors of sampling and analysis. At the end of the year, at water temperatures well below 10°C, the condition index in the western section fluctuated around 100, in the eastern section around 105.

Summarizing, it can be stated that reproduction of the oysters coincided with a rather low level of food. Excellent environmental conditions favoured rapid recuperation and led to a very good condition of the marketable oysters during hibernation.

A. C. DRINKWAARD

